Data Summary for the *Wastewater Discharge Areas Addendum to the RI/FS Work Plan*, Part 2

TECHNICAL MEMORANDUM DS NO. 18

Reynolds Metals Company
TROUTDALE FACILITY

CH2MHILL

June 17, 1998

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Abbreviations and Acronyms

bgs	below the ground surface
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CN	Curve Number
COE	U.S. Army Corps of Engineers
ft/ft	foot per foot
ft/s	feet per second
ft^3/sec	cubic feet per second
gpd	gallons per day
GS&G	Gresham Sand and Gravel
lb	pound(s)
MCL	maximum contaminant level
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
NWRC	North Willamette Research Center
OAL	Oregon Analytical Laboratory
PAHs	polynuclear aromatic hydrocarbons
QAL	Quality Analytical Laboratories
RMC	Reynolds Metals Company
UGS	upper gray sand
WDAA	*Wastewater Discharge Areas Addendum to the RI/FS Work Plan*

Executive Summary

Purpose of Memorandum

- Summarizes information collected during implementation of the *Wastewater Discharge Areas Addendum to the RI/FS Work Plan* (WDAA) (CH2M HILL, December 1997)
- Provides an evaluation of the groundwater/surface water interactions for the wastewater discharge areas (specifically, South Ditch and Company Lake)

Results of the South Ditch Evaluation

- Groundwater elevations across the site, and along South Ditch, show a downward trend between the end of May and the end of September 1997, reflecting a seasonal decline in the water table as summer progresses.
- East South Ditch, which does not receive wastewater discharges, becomes a losing ditch for a very brief period of 2 to 4 weeks during the year. During this period the ditch provides recharge to groundwater until it goes dry.
- This seasonal pattern of the ditch drying up appears to be consistent from year to year.
- Because east South Ditch goes dry about the time groundwater levels drop, the constituent migration from east South Ditch to groundwater is expected to be minimal.
- West South Ditch becomes a losing ditch around the end of June to mid-July, as groundwater levels drop below surface water levels in the ditch.
- Because this portion of the ditch receives stormwater, process water, and wastewater from several outfalls, the ditch does not go dry and continues to recharge groundwater throughout the summer and early fall.
- The best estimated order-of-magnitude flux through the bottom and sides of west South Ditch during dry season conditions is 2×10^{-04} cubic feet per second (ft^3/sec) [or approximately 129 gallons per day (gpd)].
- Based on a potential range of hydraulic conductivities that could be present in the material along the ditch walls/bottom, the flux could range from 2×10^{-05} ft^3/sec (or approximately 13 gpd) to 2×10^{-3} ft^3/sec (1,293 gpd).
- Because leakage out of west South Ditch is small (and for only a small portion of the year), the potential for surface water constituents to impact groundwater is low.
- The estimated loss of fluoride to groundwater during the period of maximum seepage is less than 1 pound (lb)/day.

Results of the Company Lake Evaluation

- Surface water in Company Lake (used as a wastewater treatment pond) recharges groundwater in the summer and fall, when groundwater elevations typically fall below the surface water elevation of the pond.

- A comparison of groundwater quality data from Geoprobes and monitoring wells in the vicinity of the pond with the results of the sediment leaching test suggests that groundwater quality downgradient of the pond is affected by seepage through the bottom of Company Lake when groundwater elevations are seasonally low.
- A vertical and a horizontal fluoride concentration gradient are evident near the pond. The vertical groundwater gradient in the vicinity of the pond is upward and groundwater flow is toward the river. The result is a localized, relatively shallow plume that discharges to the river. Fluoride concentrations from Geoprobes show a corresponding decrease as groundwater moves upward and away from the pond, likely because of mixing. Likewise, fluoride concentrations are highest near Company Lake and decline toward the river.
- Fluoride concentrations are highest near Company Lake and decline toward the river. This distribution of fluoride near Company Lake, as well as the similarity between leachate test results and fluoride concentrations in groundwater near the pond, strongly suggests that the pond is a source of fluoride to groundwater.
- The water balance indicates a loss of approximately 360,000 gpd from Company Lake to groundwater during the September-October 1997 period.
- Vertical leakage through the bottom of the pond was estimated to be 56,000 gpd.
- Because West Company Lake was backfilled with much higher conductivity dredge spoils compared with native subsurface materials, the remaining 304,000 gpd may be moving to groundwater horizontally through the west end of Company Lake. This conceptual model is supported by the observed similarity between fluoride concentrations in shallow groundwater at the west end of Company Lake and Company Lake surface water concentrations. Higher fluoride concentrations detected in intermediate-depth groundwater are more representative of the vertical seepage.
- Fluoride loading from Company Lake to groundwater was estimated at approximately 10 lb per day through vertical leakage and about 7.5 lb per day via horizontal leakage. These estimates are conservative (high) because they are based on conditions when maximum hydraulic gradients occur.
- Fluoride is present at lower concentrations in the shallow unit upgradient of Company Lake. Higher fluoride concentrations are observed in the intermediate unit (80+ feet below the ground surface). The source of this fluoride is uncertain: This deeper fluoride is either fluoride pulled down by production well pumping from a source near the main plant area, has moved downgradient after pumping demands changed and is just now moving to or by the pond, or could be the result of production well operation historically pulling fluoride down and back toward the plant from Company Lake.

Data Summary for the *Wastewater Discharge Areas Addendum to the RI/FS Work Plan*, Part 2

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DATE: June 17, 1998

Introduction

This technical memorandum summarizes information collected during implementation of the *Wastewater Discharge Areas Addendum to the RI/FS Work Plan* (WDAA) (CH2M HILL, December 1997) for the Reynolds Metals Company (RMC) facility in Troutdale, Oregon. *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997) summarized constituent concentration and distribution in South Ditch and Company Lake. This Part 2 data summary provides an evaluation of the groundwater/surface water interactions for the wastewater discharge areas.

The wastewater discharge areas comprise South Ditch and Company Lake (Figure 1), which are part of the permitted National Pollutant Discharge Elimination System (NPDES) wastewater facility. The data collection methods and results for the evaluation of groundwater/surface water interactions are presented separately for South Ditch and Company Lake.

South Ditch

The South Ditch is the primary surface water drainage feature at the RMC facility. East South Ditch begins just inside the U.S. Army Corps of Engineers (COE) dike (see Figure 1), northeast of the plant, conveying stormwater and seasonal groundwater seepage from the area west of the COE dike and east of the plant westward into west South Ditch. West South Ditch flows from the terminus of east South Ditch (just southeast of the bakehouse) to an elevation-activated pump station, conveying stormwater, seasonal groundwater seepage, and facility wastewater. The pump station discharges to Company Lake.

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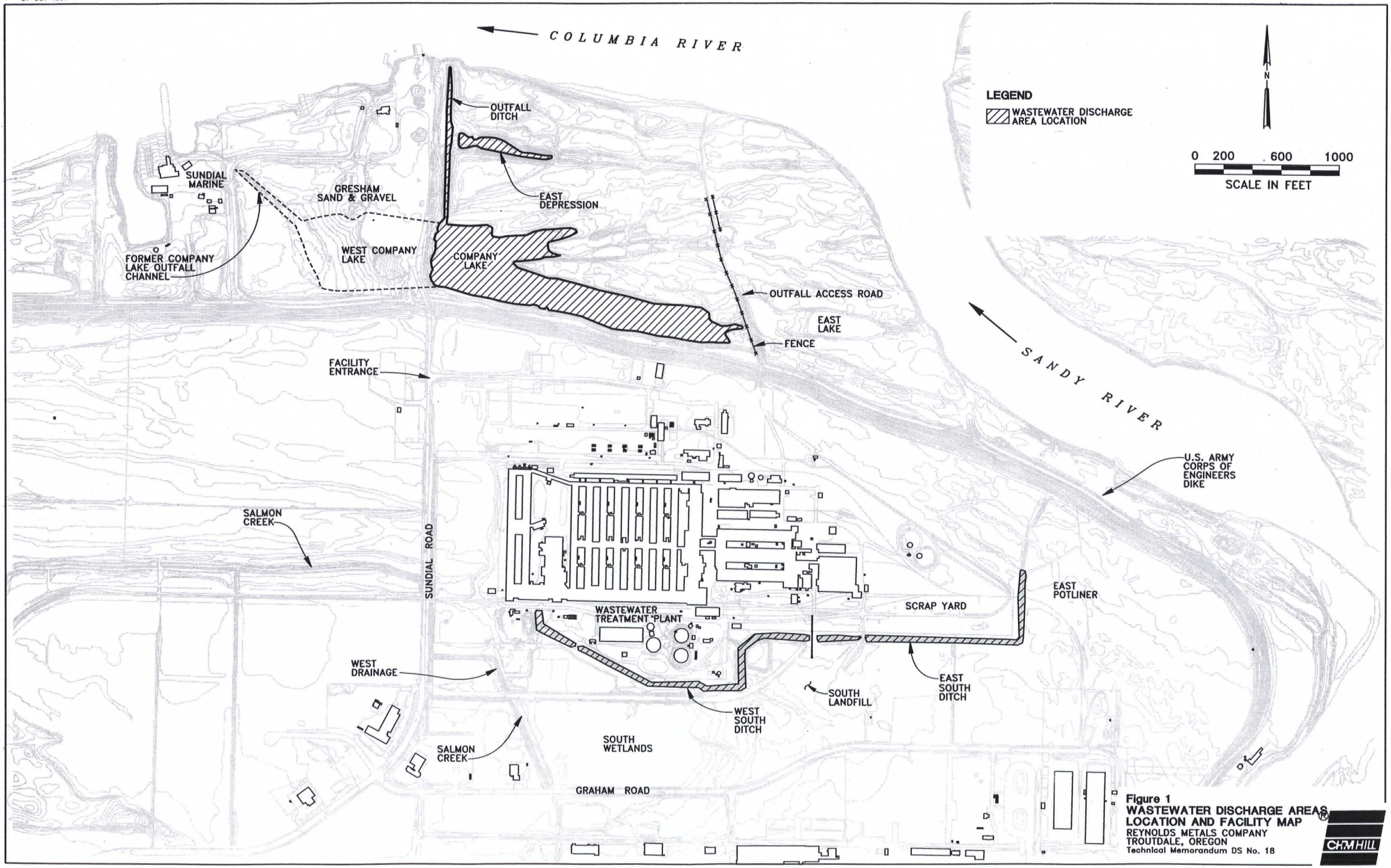

Figure 1
WASTEWATER DISCHARGE AREAS LOCATION AND FACILITY MAP
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

CH2M HILL

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RMC has dredged and straightened the South Ditch to carry surface water to the collection forebay at the pump station. The forebay is typically dredged every 5 to 6 years; it was last dredged in the winter of 1998 to restore capacity.

The WDAA called for the installation of piezometers along the South Ditch and water elevation monitoring in surface water and groundwater to provide data to evaluate surface water/groundwater interaction in the vicinity of South Ditch. Data collection methods are described in detail in the memorandum contained in Attachment A.

Groundwater elevations across the site, and along South Ditch, show a downward trend between the end of May and the end of September 1997, reflecting a seasonal decline in the water table as summer progresses.

East South Ditch, which does not receive wastewater discharges, becomes a losing ditch for a very brief period of 2 to 4 weeks during the year. During this period the ditch provides recharge to groundwater until it goes dry. This seasonal pattern of the ditch drying up appears to be consistent from year to year. Because east South Ditch goes dry about the time groundwater levels drop, the constituent migration from east South Ditch to groundwater is expected to be minimal.

West South Ditch becomes a losing ditch around the end of June to mid-July, as groundwater levels drop below surface water levels in the ditch. Because this portion of the ditch receives stormwater, process water, and wastewater from several outfalls, the ditch does not go dry and continues to recharge groundwater throughout the summer and early fall. The best estimated order-of-magnitude flux through the bottom and sides of west South Ditch during dry season conditions is 2×10^{-04} ft^3/sec (or approximately 129 gpd). Based on a potential range of hydraulic conductivities that could be present in the material along the ditch walls/bottom, the flux could range from 2.56×10^{-05} ft^3/sec (or approximately 13 gpd) to 2×10^{-3} ft^3/sec (1,293 gpd). Because leakage out of west South Ditch is small, the potential for surface water constituents to impact groundwater is low. The estimated loss of fluoride to groundwater during the period of maximum seepage is less than 1 lb/day. During the transitional periods, when groundwater elevations are declining and vertical hydraulic gradients are less than maximum, fluoride loading would be even less (for further discussion, see Attachment A).

Company Lake

Company Lake is used as part of RMC's permitted NPDES wastewater treatment system. RMC wastewater and stormwater from South Ditch enter the treatment pond from a discharge pipe at the southwest end of the pond. An outfall ditch drains from the northwest end of the treatment pond and flows north through a Parshall flume, where it discharges through an outfall pipe into the Columbia River. During periods of high water in the Columbia River, water flows into Company Lake (via the outfall ditch) from the river.

West Company Lake was once part of Company Lake but was filled and is now owned by Gresham Sand and Gravel (GS&G). Dredged materials from the river are stockpiled over West Company Lake as part of GS&G operations. Borings in West Company Lake indicate that the existing fill material is 8 to 24 feet deep.

Data Collection and Results

Data collection needs identified in the WDAA include surface water and groundwater quality monitoring, calculation of a water balance for Company Lake, a Geoprobe investigation around Company Lake, and water elevation monitoring. The data collection methods and results are provided below; the subsequent Groundwater/Surface Water Interactions section synthesizes these results into a general picture of groundwater/surface water interactions around Company Lake.

Company Lake Inlet and Outlet Water Quality Monitoring

Surface water samples were collected monthly from July to October 1997 at the inlet to Company Lake (South Ditch forebay) and at the Company Lake outlet to the Columbia River. The purpose of collecting the inlet samples was to evaluate potential compliance with the NPDES permit if South Ditch were temporarily routed directly to the river during a remedial activity. The inlet data are representative of conditions when the facility is not in production; since the samples were collected, the facility has begun aluminum production. The purpose of the outlet samples was to provide representative data to evaluate the potential leakage of Company Lake surface water to groundwater. The data collection methods and results for both the inlet and outlet samples are provided below.

Data Collection

Samples were collected directly into the sample bottles. Non-preserved sample bottles were used to fill pre-preserved sample bottles. Dissolved metal samples were field filtered using a disposable pressurized bailer and pump with a 0.45-micron disposable filter. The samples were analyzed for general chemistry, cyanide, fluoride, total and dissolved metals, and polynuclear aromatic hydrocarbons (PAHs). Surface water samples were analyzed by CH2M HILL Quality Analytical Laboratories, Redding, California; Oregon Analytical Laboratory, Beaverton, Oregon; and Analytical Resources Inc., Seattle, Washington, by the analytical methods listed in the WDAA. Field measurements (electrical conductivity, oxidation-reduction potential, pH, temperature, and turbidity) were recorded during each field event.

Results

Table 1 shows the analytical results for the inlet and outlet samples collected from July to October 1997. No cyanide was detected in any of the samples. Fluoride concentrations were consistently higher in the outlet than the inlet. Total and dissolved metal concentrations were generally higher in the inlet sample on September 18 and October 16, 1997; however, this was not the case on the other two sample dates. PAHs were detected at low levels in all the samples collected; the sum of detected PAHs ranged from 0.00046 to 0.004 milligrams per liter (mg/L). Two outlet samples were also analyzed for dissolved PAHs, but none were detected. Temperature at the inlet location was generally 10 to 15 degrees higher than at the outlet except on September 18, 1997. This sample was taken after a rain event, which might explain the decrease in the inlet water temperature.

Outlet sample results were plotted on a Piper trilinear diagram (see Figure 2). No seasonal trends in water chemistry were apparent.

Table 1
Surface Water Quality Data at the Inlet and Outlet to Company Lake

Sample ID	SD-SW006	CL-SW001	SD-SW006	CL-SW001	SD-SW006	CL-SW001	SD-SW006	CL-SW001	SD-SW006	CL-SW001
Sample Date	7/16/97	7/16/97	8/12/97	8/12/97	8/25/97	8/25/97	9/18/97	9/18/97	10/16/97	10/16/97
Description	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Analytes (mg/L)										
Field Parameters										
Conductivity (umhos)	280	230	244	251	259	276	199	191	360	160
eH (mv)	226	118	35.2	74	104	-133	108	117.3	85.4	88.4
pH	7.4	7.7	6.99	6.88	7.55	7.28	6.38	6.87	7.32	8.7
Temperature (celsius)	30.9	25.4	27.7	22.4	34.5	22.4	18.3	17.8	31.4	15.1
Turbidity (NTUs)	0.9	11.5	2.1	19	1.4	6.2	1.6	1	2.5	1.4
Conventional										
Alkalinity, Carbonate (as	6 U	6 U			6 U	6 U	6 U	6 U	6 U	18
Bicarbonate (as CaCO3)	121	95			115	104	110	107	120	66
Chloride	17	15			16.3	18.9	21.1	18.7	106	20.6
Cyanide, Total	0.02 U	0.02 U			0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Fluoride By 300.0	2.39	2.63			0.39	2.69	0.84	1.39	0.7	1.41
Nitrate-N	0.11	0.1 U	0.13	0.1			0.1	0.1 U	0.1 U	0.1 U
Sulfate	9.28	13.4			4.13	12.3	4.99	6.37	5.95	6.98
Total Metals										
Aluminum	0.0666	0.358			0.0572	0.268	0.504	0.0647	0.118 U	0.0679 U
Beryllium	0.0003 U	0.0003 U			0.0004	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Cadmium	0.002 U	0.002 U			0.0002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	20.4	20.4			22.4	23.2	24.4	24.2	49.7	22.3
Iron	0.113	0.6			0.129 U	0.413 U	0.627	0.261	0.334	0.126
Magnesium	4.01	4.26			4.02	4.4	4.21	4.18	5.1	3.81
Manganese	0.0968	0.18			0.116	0.134	0.266	0.0953	0.15	0.0367
Potassium	3.63	3.06			4.04	3.9	3.97	3.95	5.84	3.65
Sodium	25.5	20.4			20.4	25.3	22.7	20.4	53.5	20.5
Dissolved Metals										
Aluminum	0.0618	0.05 U			0.05 U	0.067	0.071	0.05 U	0.0768 U	0.05 U
Beryllium	0.0003 U	0.0003 U			0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Cadmium	0.002 U	0.002 U			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Iron	0.1 U	0.1 U			0.1 U	0.15 U	0.106	0.1 U	0.1 U	0.1 U
Manganese	0.088	0.02 U			0.108	0.0213	0.183	0.02 U	0.0899	0.023
Total PAHs[a]										
2-Methylnaphthalene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Acenaphthene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Acenaphthylene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Anthracene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(a)anthracene	0.0001 U	0.00037			0.00028	0.00027	0.00021	0.0001 U	0.0001 U	0.0001 U
Benzo(a)pyrene	0.0001 U	0.00022			0.0002	0.0002	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(b)fluoranthene	0.00029 U	0.00075			0.00079	0.00079	0.0003 Y	0.00012	0.00011	0.0001
Benzo(g,h,i)perylene	0.0001 U	0.0003			0.00034	0.00037	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(k)fluoranthene	0.0001 U	0.00056			0.00033	0.00034	0.00015 Y	0.0001 U	0.00031 U	0.0001 U
Chrysene	0.0001	0.001			0.00085	0.00088	0.00029	0.00018	0.00016	0.00023
Dibenzo(a,h)anthracene	0.0001 U	0.0001			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Dibenzofuran	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluoranthene	0.00015	0.00049			0.00014	0.00013	0.0015	0.0001 U	0.00035	0.00013
Fluorene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Indeno(1,2,3-cd)pyrene	0.0001 U	0.00033			0.0003	0.00031	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Naphthalene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Phenanthrene	0.0001 U	0.0001 U			0.0001 U	0.0001 U	0.00035	0.0001 U	0.0001 U	0.0001 U
Pyrene	0.0001 U	0.00053			0.00041	0.00045	0.0012	0.0001 U	0.00029	0.0001 U

[a] Sample CL-SW001 (7/16/97) and CL-SW001 (8/25/97) were analyzed both for total PAHs (shown) and dissolved PAHs. No dissolved PAHs were detected.

U = Undetected

Y = Indicates raised detection limit due to background interference or activity on the instrument

Figure 2

WATER CHEMISTRY IN THE VICINITY OF COMPANY LAKE

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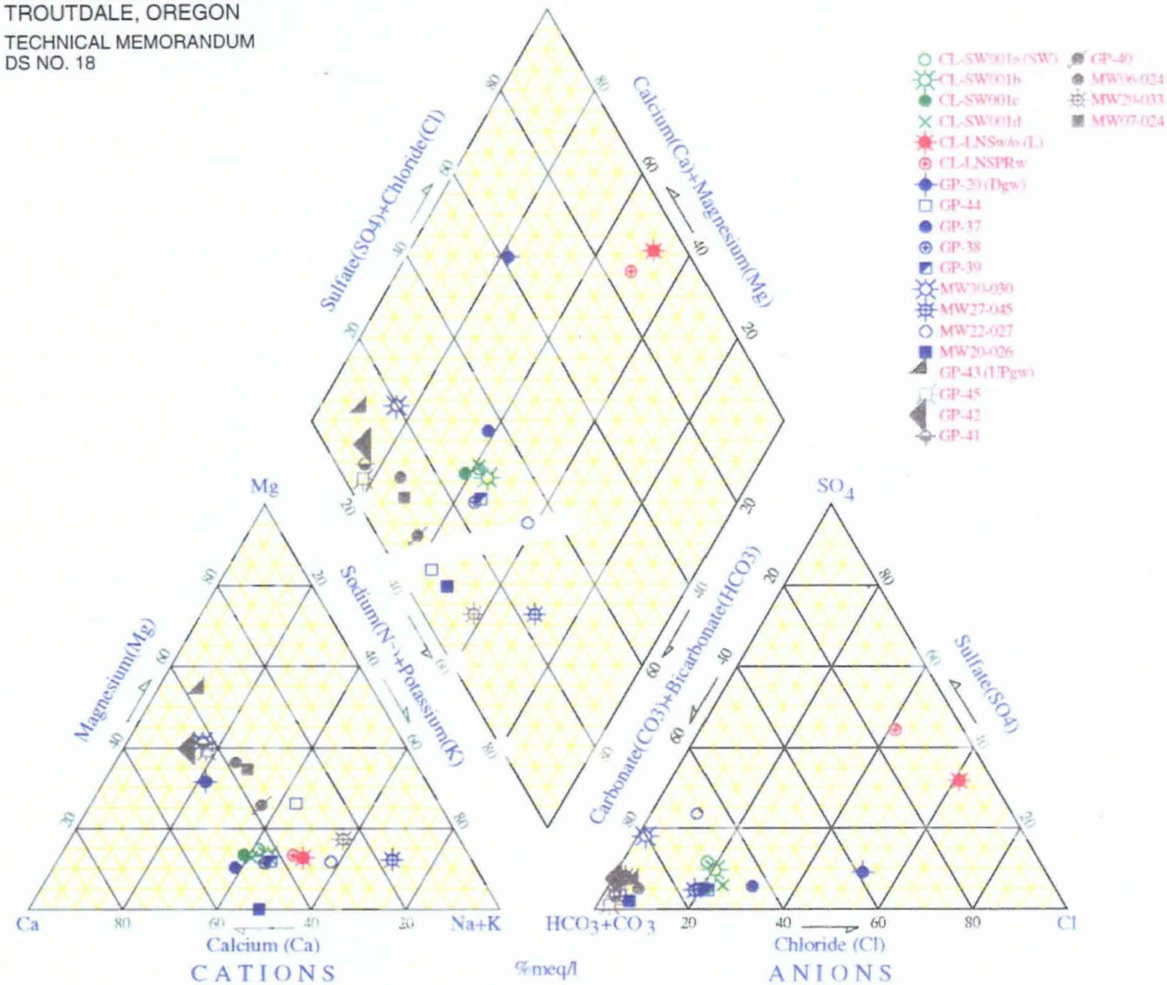

Groundwater Quality Monitoring

Sampling Procedures

Seven groundwater monitoring wells near Company Lake (MW06-024, MW07-024, MW20-026, MW22-027, MW27-045, MW29-033, and MW30-030) were monitored as part of RMC's 1997 quarterly groundwater monitoring program to determine potential upgradient and downgradient effects. Groundwater samples were collected in accordance with the procedures described in the *Draft Sampling and Analysis Plan* (CH2M HILL, July 1997) and submitted to QAL for fluoride, cyanide, total metals, PAHs, and general chemistry analysis.

Results

No cyanide was detected in any of the groundwater samples. Fluoride concentrations were consistently higher on the north (downgradient) side of the pond (from 0.55 to 23 mg/L) than on the south side (0.31 to 0.54 mg/L). Various metals were detected on both sides of the pond. No PAHs were detected. Analytical results for these seven wells are provided in the following reports:

- *Technical Memorandum No. GW-10: February 1997 Quarterly Groundwater Monitoring Results* (CH2M HILL, June 1, 1997)
- *Technical Memorandum No. GW-11: May 1997 Quarterly Groundwater Monitoring Results* (CH2M HILL, July 31, 1997)
- *Technical Memorandum No. GW-12: August 1997 Quarterly Groundwater Monitoring Results* (CH2M HILL, December 18, 1997)

Calculation of Water Balance

Between August 23 and October 20, 1997, a water balance was calculated around Company Lake to evaluate seepage to groundwater during the period of low groundwater elevation (summer months). The water balance was calculated by totaling the specific inflows and outflows from Company Lake over the duration of the water balance. The Company Lake water balance is shown conceptually in Figure 3.

Basically, the change in the volume of water in the pond is the difference between the sum of the flows into the pond and the sum of the flows leaving. The basic equation used to express this relationship is:

$$\Delta V = I + P + R - S - E - O$$

Each of the terms except seepage was quantified using the data collection procedures and simplifying assumptions presented below. The equation was then solved for "S."

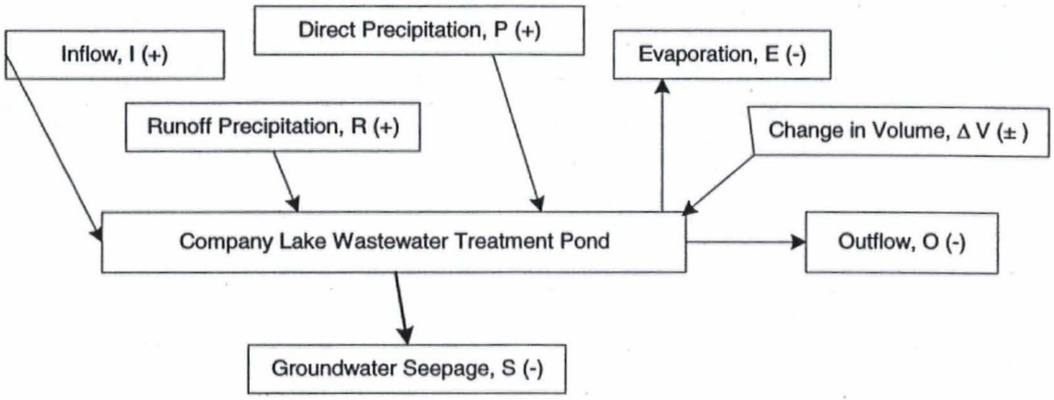

Figure 3. Company Lake Water Balance

Data Collection

Data were collected for each of the flows into and out of the pond other than seepage. Inflow and outflow values were measured directly using flowmeters installed for the water balance. Precipitation and evaporation rates were estimated using data from nearby climatological stations. Surface runoff was estimated using a calculated rainfall/runoff relationship and topographic survey data. The change in pond volume was estimated based on the difference in Company Lake water elevation between the beginning and end of the water balance.

Concurrent to the water balance, during the month of September 1997, RMC was performing an aquifer test in support of other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities. During this time, several of RMC's production wells were operated continuously at rates in excess of normal. Water from these wells was discharged to the Columbia River via South Ditch and Company Lake. Consequently, inflows and outflows from Company Lake were higher during the pumping test than occurred during most of the water balance study period.

Flows In. The calculated volumes of water into Company Lake include inflow, direct precipitation, and runoff.

Inflow (I). Inflow is defined as the combined process water and stormwater that is pumped from west South Ditch into Company Lake via a 16-inch-diameter inlet pipe. A check valve exists on the pipeline to prevent flow reversal from Company Lake. An ultrasonic flowmetering system was installed on the 16-inch-diameter pipeline upstream of the discharge to the pond. A portable metering shed adjacent to the pipe was used to house the flowmeter display unit. Totalized flow into Company Lake was recorded manually during the water balance period. Details regarding the influent flowmetering system can be found in Attachment B.

Inflow averaged 1.277 mgd and accounted for 96.4 percent of the total flow into the pond.

Direct Precipitation (P). Direct precipitation is defined as the volume of precipitation falling directly onto the water surface of the wastewater treatment pond. Precipitation depth onto the surface of the pond was estimated using data from the Bonneville Power Administration (BPA) Substation. Daily data for Monday through Friday were collected at the BPA site adjacent to RMC's plant site; these data were obtained from the Oregon Climate Service at Oregon State University.

The cumulative direct precipitation volume was calculated by multiplying the total rainfall depth times the average pond surface area during the balance.[1] The measured precipitation during the water balance period was 6.42 inches. Over the duration of the water balance, the direct precipitation term accounted for 48,100 gpd or 3.6 percent of the total flow into the pond.

Runoff (R). Precipitation runoff is defined as the volume of water flowing overland into the wastewater pond from the surrounding drainage basin. Rainfall that infiltrates or is intercepted through surface wetting or depression storage before reaching the pond is excluded from this term. To estimate this value, a topographic map of the area was used to delineate the basin that would drain to the pond. The basin was divided into two contiguous subbasins based on proximity to the pond, surface slope, and vegetation type. Stormwater runoff volumes were calculated using the Soil Conservation Service Curve Number (CN) method (Corbitt, 1990). Runoff characteristics for the two areas are presented in Table 2.

Table 2
Sub-Basin Characteristics For Precipitation Runoff

Characteristic or Value	Company Lake Shoreline	North of Company Lake
Physical Characteristics	Immediately adjacent to pond, relatively steep slope, moderate surface soil permeability, thin vegetation	Segregated from pond, gentle slope, thick vegetation as inhibitor to flow
Surface Area (acres)[1]	9.07 at 16.37 ft msl[5] 10.02 at 15.16 ft msl	25.16
Antecedent Moisture Condition (AMC)[2]	II	II
Hydrologic Soil Group (HSG)[3]	B	B
Land Use	Woodland, poor cover	Woodland, good cover
Curve Number (CN)	66	55
Potential Maximum Retention (S)	5.15	8.18
Abstraction Value (AV)[4]	1.03	1.64

[1] Accounts for varying water surface area in wastewater pond.
[2] AMC II = average soil moisture conditions
[3] HSG B = Soils having a moderate infiltration rate when thoroughly wetted and consisting chiefly of moderately deep to deep and moderately well to well-drained soils with moderately fine to moderately coarse texture.
[4] AV = The abstraction value is defined as the required rainfall depth that will be taken up by interception, depression storage and infiltration before precipitation runoff begins. An area having an abstraction value of 1.03 will require greater than 1.03 inches of precipitation to result in rainfall runoff.
[5] msl = mean sea level.

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[1] Company Lake survey data were used to adjust direct precipitation, runoff precipitation, and evaporation values for changes in pond elevation. During the water balance, RMC provided CH2M HILL with pond depths recorded using the bubbler flowmeter integral to the Parshall flume.

Because there were no days during the August 23 to October 20, 1997, water period that exceeded 1.03 inches in precipitation, the calculated runoff precipitation volume during the water balance was zero.

Flows Out. The calculated volumes of water out of Company Lake include outflow and evaporation.

Outflow (O). Surface water outflow from the wastewater pond discharges through the Parshall flume. The recommended flow rate through a Parshall flume of this size ranges from 0.112 to 15.9 mgd.[2] At the low flows typical during the summer months, the Parshall flume is in the lower 10 percent of its calibration range. Therefore, to improve the accuracy of the effluent flow measurements, a new outfall metering structure was constructed downstream of the existing Parshall flume at the discharge from Company Lake.

The new metering station consisted of a concrete drop inlet structure and an 8-inch-diameter discharge pipe. The ultrasonic flowmeter transducers were installed on the submerged portion of the 8-inch-diameter pipe; the meter and datalogger were located inside the existing monitoring station. Totalized and instantaneous flow values were recorded using a datalogger and downloaded periodically. Details regarding the effluent flowmetering system can be found in Attachment B.

Outflow averaged 0.932 mgd and accounted for 70.3 percent of the total flows out of the pond.

Evaporation (E). Evaporation from the surface of the wastewater pond was estimated using data collected from the North Willamette Research Center (NWRC) in Aurora, Oregon. Aurora is located west of the Cascades and has a mid-latitude coastal climate similar to Troutdale. These data were obtained from the Oregon Climate Service at Oregon State University. The NWRC is the closest meteorological station to Troutdale that collects evaporation data.

The NWRC evaporation data were reported in terms of net water loss; that is, the change in water depth in a pan of water in a day as a result of precipitation and evaporation. Pan evaporation was calculated by adding the reported precipitation and net water loss values. Pan evaporation rates are higher than actual lake evaporation and must be adjusted to account for radiation and heat exchange effects. Accordingly, the pan evaporation value was adjusted by a pan coefficient of 0.70, an average value for the United States.

The cumulative direct evaporation volume was calculated by multiplying the daily pan evaporation value times the average pond surface area during the balance. Over the duration of the water balance, the evaporation term accounted for 36,700 gpd or 2.8 percent of the total flows out of the pond.

Change in Volume (ΔV). A predominant function of the wastewater treatment pond is to serve as an equalization basin to attenuate peak flows and loads. In response, the level of the pond is continually rising or falling depending on the relative inflow and outflow rates. The change in volume over any time period is reflected in the ΔV term of the water balance equation. When the total flows into the pond exceed the total flows out, the volume of the

[2] ISCO Open Channel Flow Measurement Handbook, Second Edition, 1985; Parshall flume with throat width of 18 inches.

pond increases (ΔV is positive); when the flows out exceed the flows in, the pond volume decreases (ΔV is negative).

Results

The cumulative totals for the various inflow and outflow terms and the calculated seepage term are shown in Table 3.

Table 3
Average Daily Flows for Company Lake

Into Pond (gpd)		Out of Pond (gpd)	
Inflow (I)	1,277,840	Outflow (O)	(932,680)
Direct Precipitation (P)	48,120	Evaporation (E)	(36,750)
Runoff Precipitation (R)	0	Seepage (S)	(356,530)
TOTAL	1,325,960		(1,325,960)

Solving for S in the equation on page 7, the average seepage rate over the duration of the study is estimated at approximately 360,000 gallons per day. Because the seepage rate is calculated based on the other inflow and outflow values, any error in the other terms is reflected in the seepage term. Given the range of uncertainty in the other terms, the calculated seepage rate during the water balance period may vary between approximately 280,000 gpd and 430,000 gpd.[3] This range is representative of the seepage rate for low water table conditions such as those typically present during the summer months. On the basis of known groundwater elevations and the conceptual model for groundwater surface water interaction in the pond, seepage during other times of the year is likely to be substantially less.

Geoprobe Investigation

A Geoprobe investigation was conducted around Company Lake to assess groundwater quality immediately upgradient and downgradient of Company Lake.

Sampling Procedures

A total of eleven Geoprobes [five upgradient (GP40-GP43 and GP45) and six downgradient (GP20, GP21, GP37-GP39, and GP44)] were advanced to depths ranging between 40 and 100 feet below the ground surface (bgs). The field work was conducted in September 1997 to coincide with seasonal low groundwater elevations when Company Lake effects on shallow groundwater, if any, were likely to be most pronounced. Geoprobe locations are shown in Figure 4. [Note: Geoprobes on the south side were located farther away from the pond in

[3] Assuming ±20% error in natural terms (precipitation, runoff precipitation, evaporation); ±3.5% error in inflow term calculated based on probable corrosion in pipe and instrument accuracy; ±1% error in outflow term calculated based on instrument accuracy. Minimum value calculated by subtracting the high-end outflow terms (i.e., 101% O + 120% E) from the low-end inflow terms (i.e., 96.5% I + 80% P + 80% R). Maximum value calculated by subtracting low-end outflow terms from high-end inflow terms.

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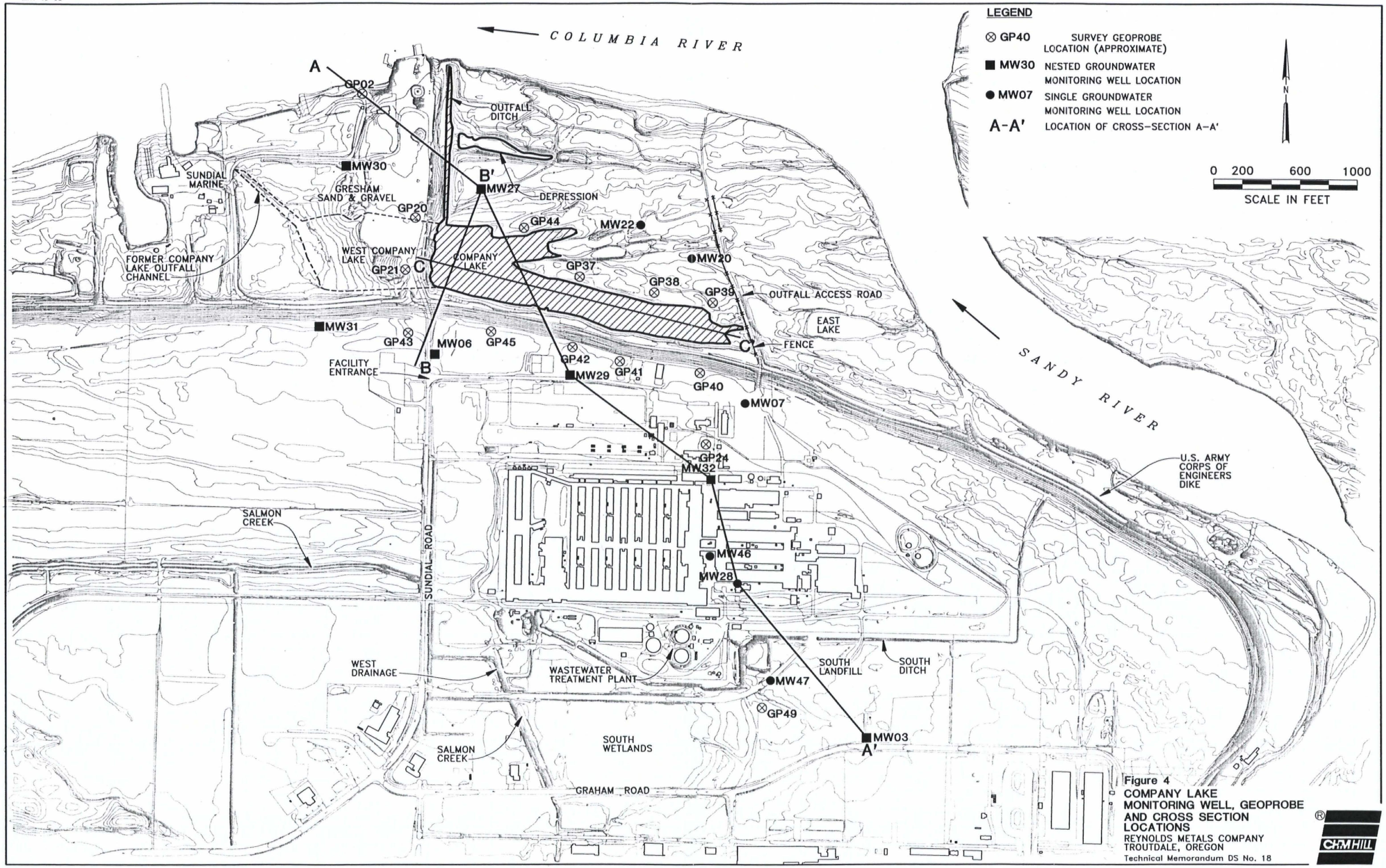

Figure 4
COMPANY LAKE MONITORING WELL, GEOPROBE AND CROSS SECTION LOCATIONS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

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order to avoid the COE dike.] Water samples were collected and analyzed in the field for fluoride, pH, temperature, specific conductance, and oxidation-reduction potential at 10-foot intervals. Groundwater grab samples were collected from 5 to 10 feet below the top of the water table at each Geoprobe location and submitted to QAL for fluoride, cyanide, total metals, PAHs, and general chemistry analysis. Groundwater samples were collected in accordance with the procedures described in the *Draft Sampling and Analysis Plan* (CH2M HILL, July 1997). Geoprobe field data are provided in Attachment C of *Technical Memorandum No. GW-12: August 1997 Quarterly Groundwater Monitoring Results* (CH2M HILL, December 18, 1997). Analytical results for the Geoprobe grab samples are provided in Attachment C of this document.

Results

The horizontal distribution of fluoride in the upper gray sand (0 to 52 feet bgs) and intermediate-depth sand units (62 to 100 feet bgs) in the vicinity of Company Lake is shown on Figures 5 and 6, respectively. [Note: Figures 5 and 6 were prepared for a different report (CH2M HILL, December 18, 1997) and show areas of fluoride concentrations (near wells MW13-022, MW33-095, and MW34-038) that are not relevant to this document.] Maximum fluoride concentrations were posted for each of the units, and concentration contours were developed. The August 1997 distribution of fluoride in groundwater is addressed below for the upper gray sand and intermediate-depth sand.

Upper Gray Sand (UGS). The Geoprobe results indicate both a horizontal and a vertical fluoride concentration gradient near Company Lake. On the north (downgradient) side, the fluoride distribution in Geoprobes 20, 37, 38, 39, and 44 ranged from 2.9 to 17.1 mg/L near the water table (20 to 30 feet bgs). The maximum fluoride concentrations in these Geoprobes, encountered between 32 and 52 feet bgs, ranged from 15.9 to 24.5 mg/L (see Figure 5).

Fluoride is present at lower concentrations (0.27 to 2.85 mg/L) near the water table (20 to 30 feet bgs) in Geoprobes GP40 through 43 and GP45, located on the south (upgradient) side of the pond. The maximum fluoride concentrations in upgradient Geoprobes ranged from 0.37 to 9.45 mg/L at depths of 32 to 52 feet bgs.

Intermediate-Depth Sand

The Geoprobe locations along the north side of Company Lake were not advanced beyond the proposed depth of 42 feet bgs; therefore, fluoride concentration data are not available for the intermediate-depth sand north of the pond. However, the 4 to 15 mg/L contour interval (blue-shaded area), shown in Figure 6, has been extended north of the pond because the magnitude of the concentrations in the overlying UGS suggest that fluoride is likely to be present at or above 4 mg/L in the intermediate-depth sand.

On the south (upgradient) side of Company Lake, fluoride is present at higher concentrations (4.64 to 20.5 mg/L) in the intermediate depths (+80 feet bgs).

The vertical distribution of fluoride concentrations in groundwater near Company Lake is illustrated in cross sections A-A′ and B-B′ (Figures 7 and 8; see Figure 4 for cross-section locations). The cross sections were developed using field fluoride data from 1996 Phase I

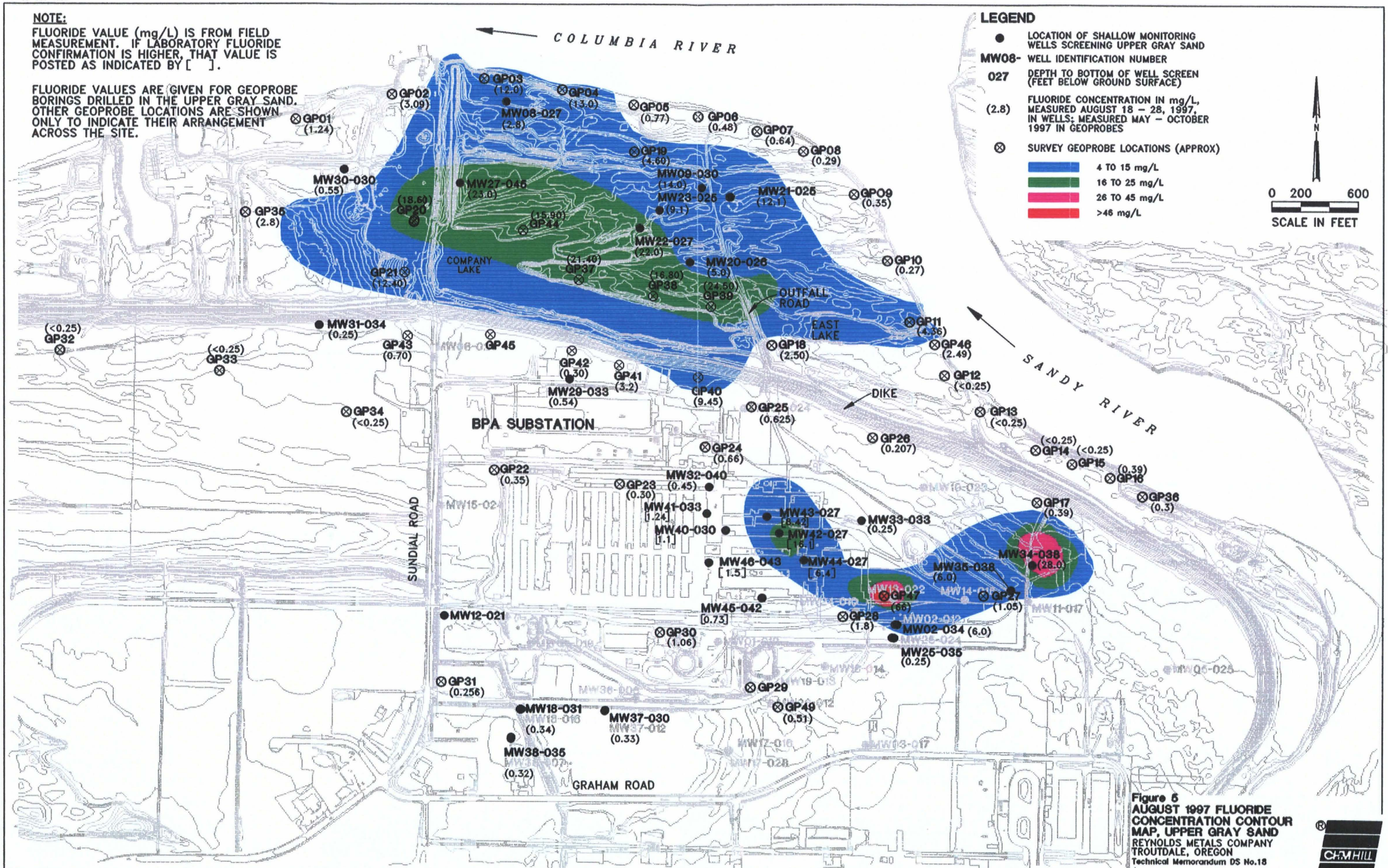

Figure 5
AUGUST 1997 FLUORIDE CONCENTRATION CONTOUR MAP, UPPER GRAY SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No.18

CH2M HILL

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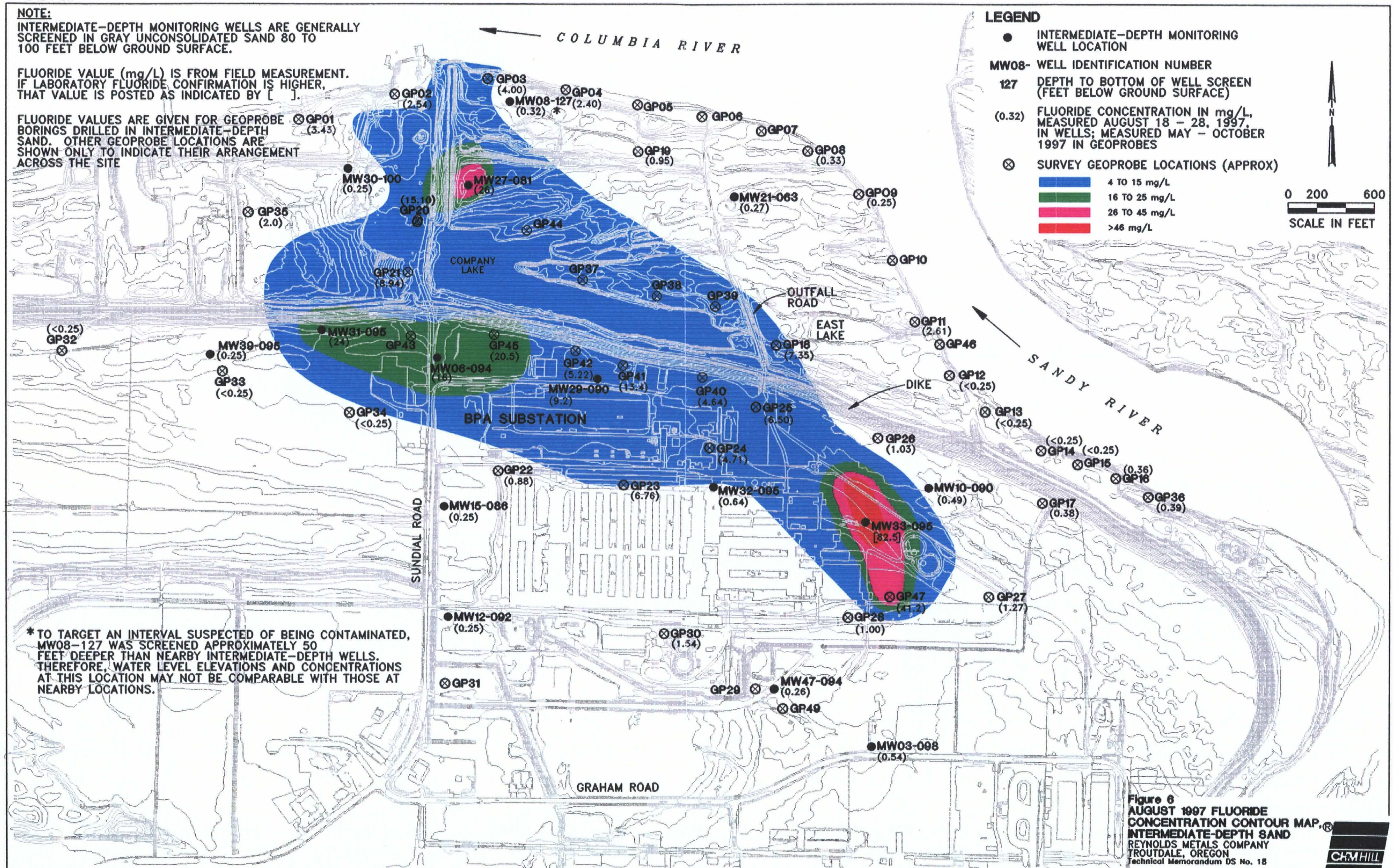
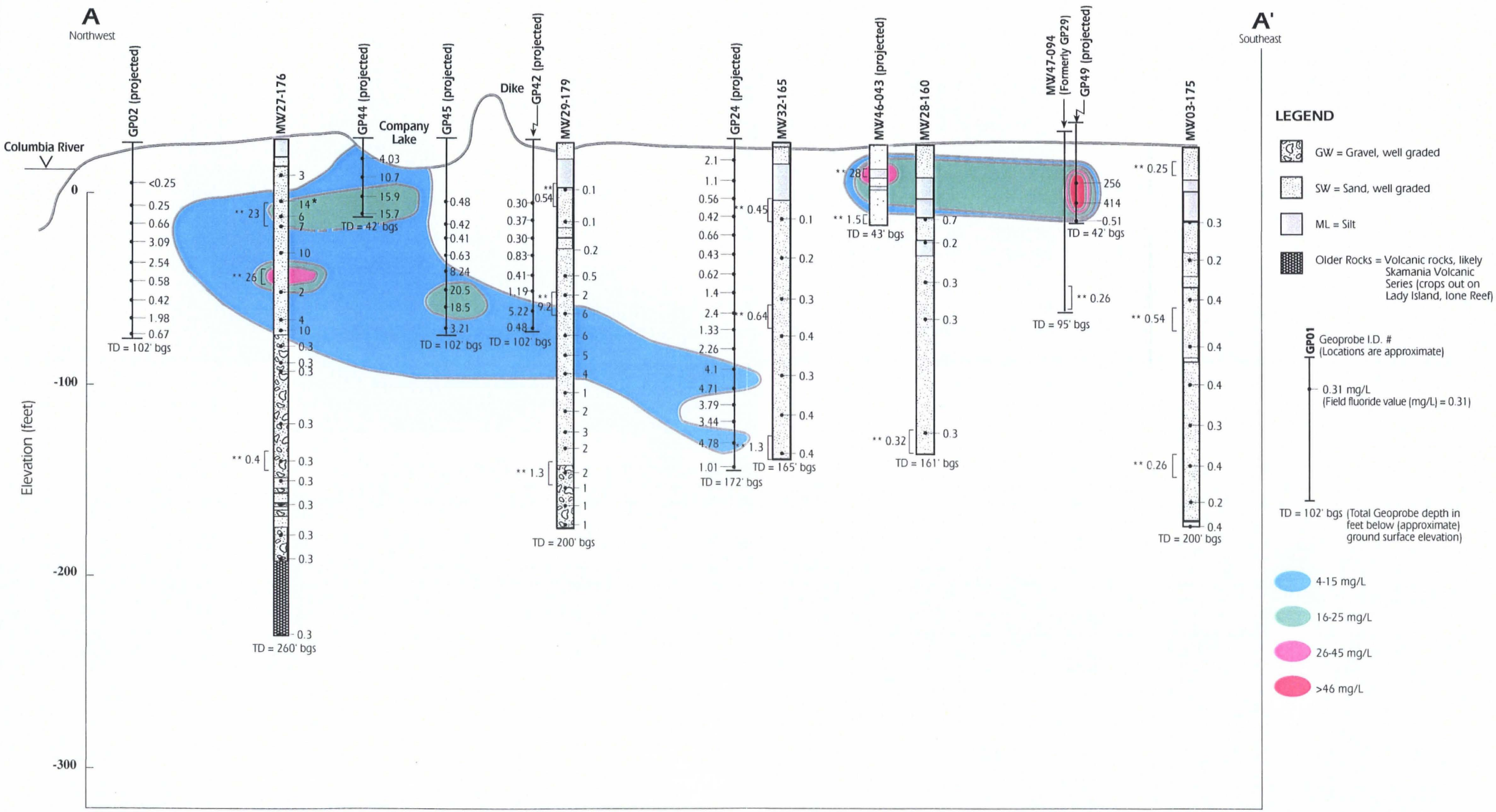


Figure 6
AUGUST 1997 FLUORIDE CONCENTRATION CONTOUR MAP, INTERMEDIATE-DEPTH SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

CH2M HILL

COLOR5.DWG



Notes: Values to the right of each well column indicate fluoride readings taken during drilling of the identified well; note that in most cases the well column actually represents a group of wells, whose screen intervals are indicated by a bracket to the left of the column (see Table 1 for well-specific information).

Field-measured fluoride concentrations were obtained by screening borehole water samples with an Orion fluoride probe during Phase 1 and Phase 1A drilling (April 1996 to December 1996) and during the Geoprobe investigation (summer 1997).

* November 1996 fluoride concentration from MW27-045 monitoring well.

** August 1997 fluoride concentration data (mg/L).

Approximate Scales:

Horizontal scale: **1 inch = 500 feet**

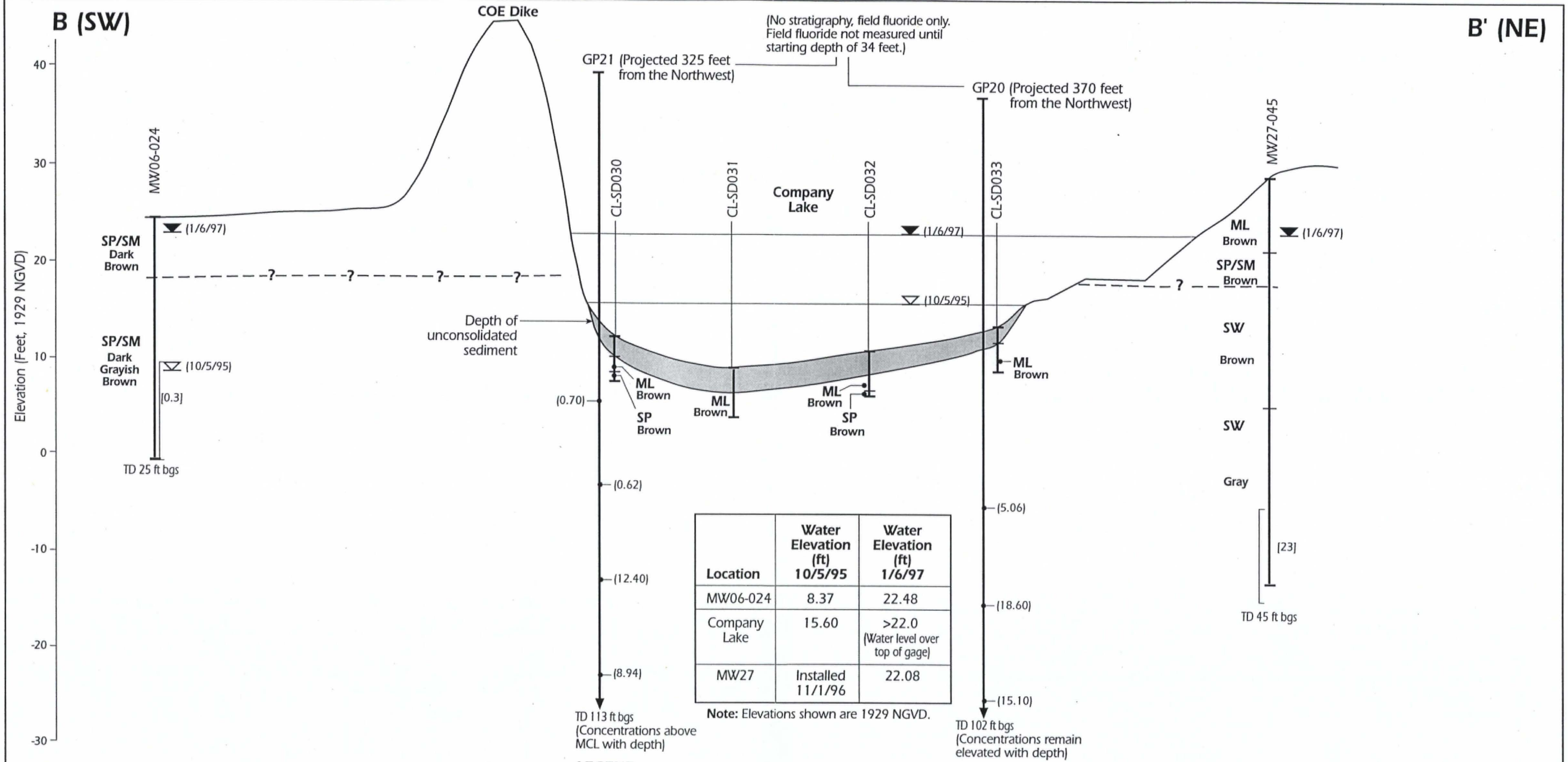
Vertical scale: **1 inch = 50 feet**

Vertical exaggeration: **10x**

Elevation relative to the 1929 NGVD

Figure 7
CROSS SECTION A-A'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
TECHNICAL MEMORANDUM
DS NO. 18

CH2M HILL



Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW06-024	8.37	22.48
Company Lake	15.60	>22.0 (Water level over top of gage)
MW27	Installed 11/1/96	22.08

Note: Elevations shown are 1929 NGVD.

LEGEND

MW09 ← Monitoring or geoprobe well number

← Cased interval

← Screened interval

TD 25 ft bgs ← Total depth

▼ 1/6/97 water level elevation

▽ 10/5/95 water level elevation

Primary source material

[0.3] Laboratory fluoride values (mg/L) (August 97 quarterly sampling)

(0.4) Field fluoride values (mg/L) (Summer/Fall 97 drilling/Geoprobe program)

ML = Silt

SP = Poorly graded sand

SW = Well-graded sand

SM = Silty sand

0 50 100 Feet

Approximate Horizontal Scale

0 5 10 Feet

Approximate Vertical Scale

Vertical exaggeration = 10x

Figure 8

COMPANY LAKE
CROSS SECTION B-B'

REYNOLDS METALS COMPANY
TROUTDALE, OREGON

TECHNICAL MEMORANDUM
DS NO. 18

monitoring well drilling, Geoprobe field fluoride data collected during summer 1997, and field fluoride data from the August 1997 quarterly groundwater monitoring event.

In general, cross-section A-A′ shows the following:

- The fluoride distribution appears asymmetrical, with respect to depth, in the vicinity of Company Lake. Fluoride concentrations higher than the maximum contaminant level (MCL) (depicted by the 4 to 15 mg/L contour interval) are present in the UGS beneath and downgradient of the pond. On the south side of the pond, fluoride concentrations above the MCL are not present in the UGS but are encountered at greater depth in the intermediate-depth sand. This interpretation of vertical distribution correlates with the horizontal fluoride concentration contours shown on Figures 5 and 6.
- There appears to be a downward trend in the fluoride distribution to the southeast in the direction of the plant. Fluoride concentrations above the MCL are encountered in the intermediate-depth sand at MW29 (upgradient of Company Lake) and in the deep sand/gravel at Geoprobe GP24. It is unclear whether the fluoride distribution presented in this cross section results from onsite production well pumping (that is, pulling shallow fluoride in the vicinity of Company Lake back toward the plant) or from fluoride migrating from sources to the south under "natural" hydraulic gradients.

Cross-section B-B′ depicts the vertical distribution of fluoride at the west end of Company Lake (see Figure 8). Fluoride was measured at 0.7 mg/L at Geoprobe GP 21, near the water table (20 to 30 feet bgs). The maximum fluoride concentrations measured in the UGS at locations GP20 and GP21 ranged from 12.4 to 18.6 mg/L and were encountered at 32 to 52 feet bgs. In the intermediate-depth sands, maximum fluoride concentrations ranged from 8.94 to 15.1 mg/L at 62 feet bgs.

Water Elevation Monitoring

As part of RMC's groundwater program, the entire sitewide monitoring well network and all staff gauges were measured monthly between June 1994 and March 1998. Data collected at the Columbia River and seven groundwater monitoring wells adjacent to Company Lake were plotted as hydrographs to assess surface water/groundwater interaction. Because of a lack of sufficient staff gauge measurements, an average surface water elevation of 15.5 feet (the elevation of the Parshall flume) was used to represent Company Lake. Under normal conditions, the water level in Company Lake is stable because it is controlled by the Parshall flume located at the outlet to the Columbia River. Water elevation data are presented in Attachment D.

Figure 9 compares shallow groundwater elevations in the vicinity of Company Lake with a representative Company Lake surface water elevation for a period of 3 ¾ years. The hydrograph shows surface water recharging groundwater for a period of 13 months (June 1994 to October 1995) during drought conditions, when groundwater levels were lower than normal (with the exception of MW07-024). Monitoring well MW07-024, located just south of the COE flood control dike, lies in an area characterized by an elongate groundwater mound. The mound is the result of a band of low-permeability soil (observed during drilling) coincident with an area of concentrated surface water recharge. Water has been observed to pond in this location during periods of increased precipitation.

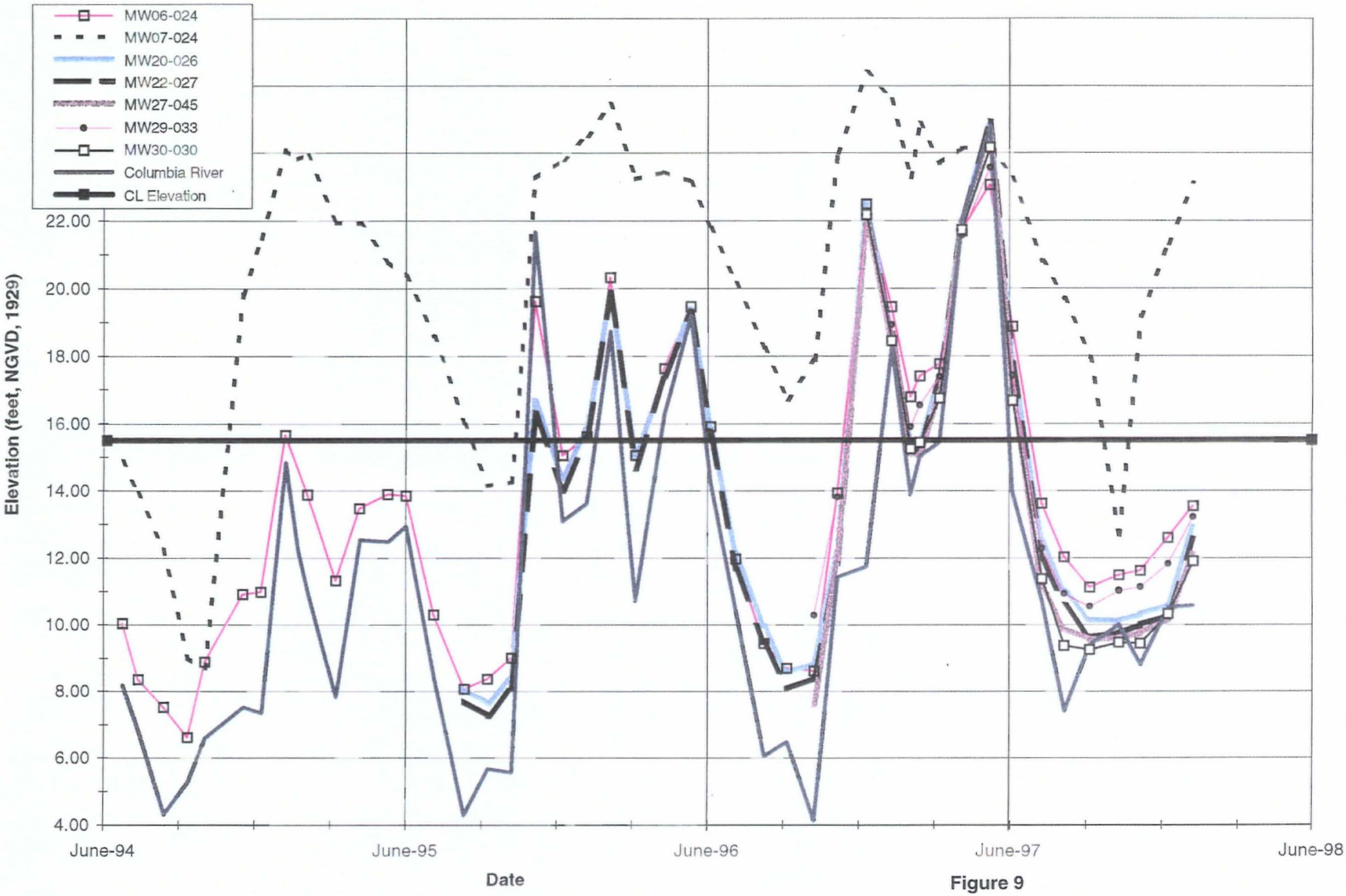


Figure 9

1994-1997 GROUNDWATER LEVELS FOR UGS WELLS NEAR COMPANY LAKE

REYNOLDS METALS COMPANY
TROUTDALE, OREGON

TECHNICAL MEMORANDUM
DS NO. 18

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As expected, groundwater levels rise in response to increasing precipitation from October 1995 through June 1996 (winter/spring), and groundwater discharges to Company Lake for a period of approximately 7 ½ months (excluding two brief periods lasting 4 and 2 weeks, respectively; see Figure 9). By mid-February, flood conditions resulting from heavier than normal rainfall are observed. This condition persists until June 1996, when precipitation decreases, the Columbia River stage starts to drop, and groundwater levels start to fall below surface water levels in the pond, reflecting a seasonal decline in the water table as summer progresses. During this transition period, Company Lake becomes a losing surface water body and begins recharging groundwater for a period of approximately 6 months (June to November 1996, summer/fall).

The same cycle repeats in 1997. Precipitation increases in October/November 1996, groundwater levels rise above surface water levels, and groundwater discharges to Company Lake for approximately 7 months (excluding one brief period of recharge). In May, precipitation begins to decrease and the Columbia River stage drops 11 feet. By July 1997, groundwater levels have fallen below surface water levels and the pond has begun to recharge groundwater. Figure 10 illustrates the change in surface water/groundwater interactions through the year.

Groundwater/Surface Water Interaction

Surface water in Company Lake recharges groundwater in the summer and fall, when groundwater elevations typically fall below the surface water elevation of the pond. Because the treatment pond has been used as part of the facility's wastewater discharge system for more than 50 years, it is assumed that the existing groundwater quality conditions are representative of long-term conditions. Consequently, Company Lake effects on groundwater quality were evaluated by comparing the results of the sediment leachate test described in the *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997) and surface water quality at the outlet to Company Lake with groundwater quality data collected at upgradient and downgradient monitoring wells (see Tables 1, 4, and 5).

Figure 2, a Piper trilinear diagram, displays the results of the water-chemistry comparison. Calcium and magnesium appear to be the dominant cations in groundwater, and more distinctly, bicarbonate is the dominant anion. As shown in Figure 2, surface water and leachate cluster tightly in separate areas of the diamond-shaped portion of the diagram. Upgradient groundwater displays a lateral cation scatter but is consistently high in bicarbonate. The downgradient groundwater samples show the greatest diversity in water type. Chloride levels are low in some downgradient samples and increase to levels similar to the surface water samples and, in one case, to levels near the leachate samples. This distribution of the downgradient groundwater samples suggests mixing is occurring between the upgradient groundwater and surface water (and in some instances with leachate). The cation/anion balances for groundwater and leachate indicate that some anions, possibly fluoride, are not accounted for in the balance.

Maximum fluoride concentrations measured in the downgradient Geoprobes (15.9 to 24.5 mg/L at an average depth of 42 feet bgs) are comparable to the sediment leachate test results (18.2 to 23.2 mg/L) (CH2M HILL, December 12, 1997). This similarity of groundwater fluoride concentrations to the leachate also suggests that groundwater quality

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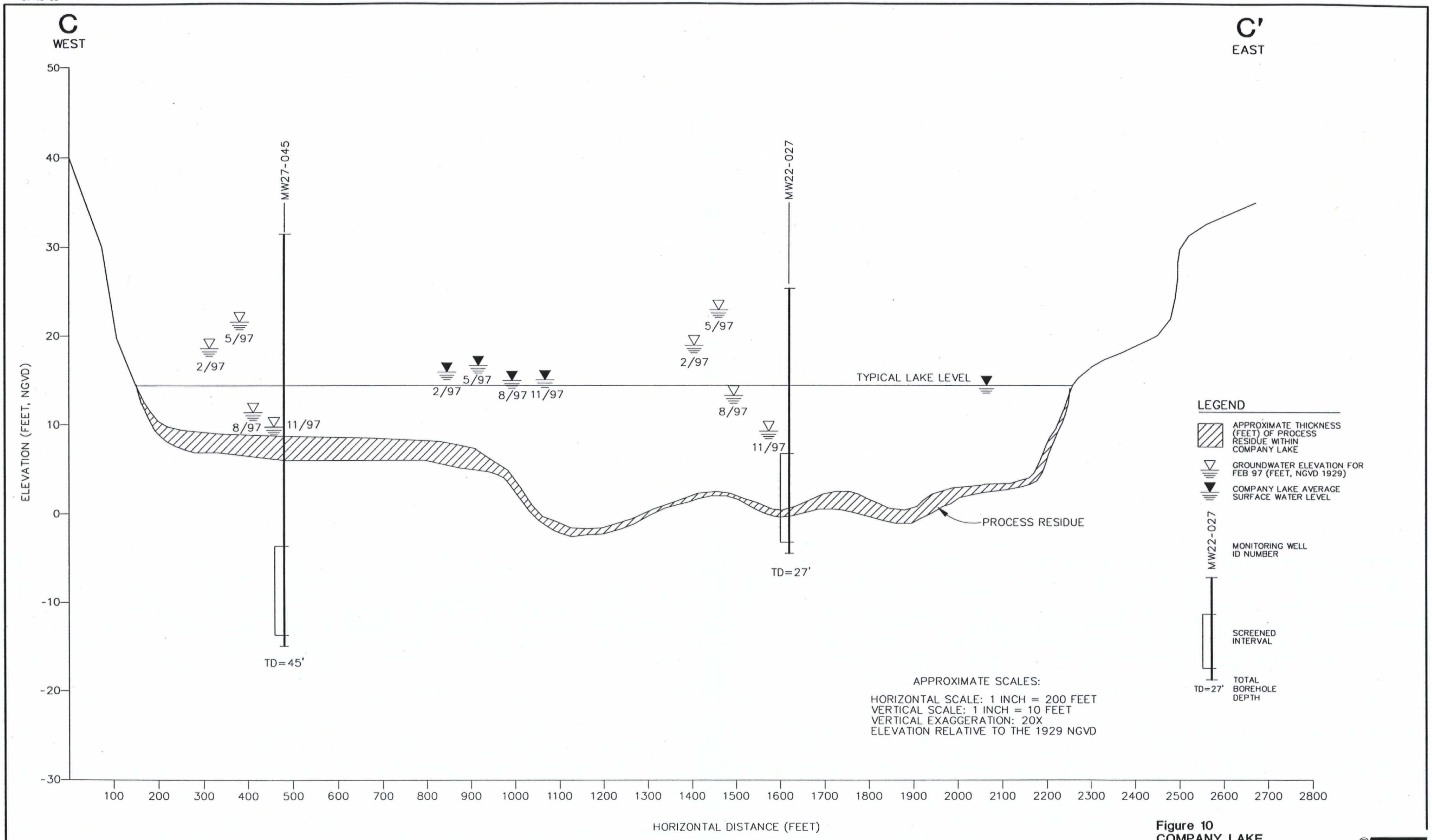

Figure 10
COMPANY LAKE
CROSS SECTION C-C'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

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Table 4
Comparison of Company Lake Sediment Leachate Results with
Downgradient Groundwater Quality

Sample Matrix	Leachate [a]		Geoprobes [b]					Monitoring Wells [c]			
Sample ID	**CL-LNS**	**CL-LNSPR**	**GP-20**	**GP-44**	**GP-37**	**GP-38**	**GP-39**	**MW30-030**	**MW27-045**	**MW22-027**	**MW20-026**
Sample Description	Composite w/out PR	Composite w/ PR	Groundwater sampled just below the water table - September 1997					Groundwater sampled August 1997			
Analyte (mg/L)											
Conventionals											
Fluoride (300.0)	22.2	21.5	4.45	4.45	17.1	2.9	11.4	0.55	23	22	5
Cyanide	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Chloride	42.8	49.7	58.3	3.65	40.8	21.6	19.8	1.41	26.5	9.96	4.35
Sulfate	30.1	72	14	4.54	10.3	7.7	6.02	19.7	9.08	32.6	2
Bicarbonate	2.2	23.2	68	146	140	137	110	104	178	110	101
Carbonate	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Nitrate-N	0.1 U	0.1 U	0.1	0.1 U	1 U	1 U	1 U	1.6	0.1 U	0.3	0.1
Metals											
Aluminum	0.063	0.05 U	0.323	0.363	1.13	0.112	0.519	0.05*** U	0.689	1.81	0.239
Beryllium	0.00035	0.00035	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0018	0.0013	0.00039
Cadmium	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium	41.5	54.1						18.5	15.9	19.8	15.4
Iron	0.234	0.114	7.05	0.17	5.7	0.102	0.488	0.1 U	5.79	0.1 U	0.1 U
Magnesium	9.09	11.9						11	7.17	4.74	0.02 U
Manganese	2	2.88	0.152	0.0278	1.04	0.0777	0.1	0.02 U	0.231	0.02 U	0.02 U
Potassium	4.09	4.13						1.05	2.68	2.46	1.52
Sodium	67.5	80.8						7.42	76.1	42.7	16.1

PR = Process residue
U = Undetected
a from *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997).
b All metals analyzed as dissolved metals.
c Monitoring well samples were analyzed for total metals except for manganese, which was analyzed for dissolved metals.

Table 5
Groundwater Quality Upgradient of Company Lake

Sample Matrix	Geoprobe [a]					Monitoring Well [b]		
Sample ID	GP43	GP45	GP42	GP41	GP40	MW06-024	MW29-033	MW07-024
Sample Description	Groundwater sampled just below the water table - September 1997					Groundwater sampled August 1997		
Analyte (mg/L)								
Conventionals								
Fluoride (300.0)	0.27	0.29	0.25 U	0.25 U	2.85	0.31	0.54	0.32
Cyanide	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Chloride	6.86	2.18	3.45	2.92	1.05 U	3.08	2	1.82
Sulfate	9.29	1.24	18.1	4.51	2.58	3.07	9.21	8.58
Bicarbonate	161	127	268	163	39	62	121	117
Carbonate	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Nitrate-N	0.1 U	0.1 U	0.1 U	0.1 U	1.3	0.7	0.1 U	3.6
Metals								
Aluminum	0.268	0.221	0.0569	0.0844	0.595	0.05 U	0.0946	0.05 U
Beryllium	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Cadmium	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Calcium						9.23	10.6	17.5
Iron	2.1	2.99	14.3	0.924	1.68	0.1 U	8.43	0.1 U
Magnesium						5.36	4.54	10.1
Manganese	0.663	1.05	5.65	0.234	0.0803	0.02 U	1.18	0.02 U
Potassium						2.08	2.79	1.62
Sodium						5.91	26.9	15

[a] Geoprobe samples analyzed for dissolved metals.
[b] Monitoring well samples were analyzed for total metals except for manganese, which was analyzed for dissolved metals.

downgradient of Company Lake is affected by leachate migrating through the bottom of Company Lake. The vertical hydraulic gradient in the vicinity of Company Lake is small and generally upward. Horizontal groundwater flow is toward the river. Geoprobe fluoride concentrations show a corresponding decrease (2.9 to 17.1 mg/L at 20 to 30 feet bgs) as groundwater moves upward and away from the pond, likely because of mixing.

From the combined Geoprobe and monitoring well data, a horizontal fluoride concentration gradient is also apparent, downgradient of the lake. Fluoride concentrations are highest near Company Lake and decline toward the river, as depicted in Figure 5. This distribution of fluoride near Company Lake and the similarity between leachate test results and fluoride concentrations in groundwater near the pond strongly suggest that the pond is a source of fluoride to groundwater. On the upgradient side (or south side) of Company Lake, fluoride is present at lower concentrations in the shallow unit and at higher concentrations in the intermediate depths (+80 feet bgs) (see Figures 5, 6, and 7 and Table 5). The source of the fluoride is uncertain; two transport scenarios could explain this fluoride distribution. The first is that the deeper fluoride originated back at a source area near the main plant and was pulled down by historical production well pumping. After pumping demands changed, the fluoride moved downgradient and is just now moving to or past the pond. The second transport scenario is that fluoride could be the result of production well operation historically pulling fluoride down and back toward the plant from Company Lake.

The water balance discussed earlier indicates a loss of approximately 360,000 gpd from Company Lake to groundwater during the September-October 1997 period. Using the permeability results for the sediment, the vertical leakage through the bottom of Company Lake was estimated to be 56,000 gpd using Darcy's equation:

$$Q = KiA$$

where:

Q= quantity of flow per unit time, in cubic feet per second (ft^3/s).

K = hydraulic conductivity, in feet per second (ft/s). The vertical hydraulic conductivity was calculated by averaging the results of the Company Lake sediment (composed of process residue and native sediment) permeability tests (CH2M HILL, December 12, 1997). K= $1.26x10^{-07}$ ft/sec.

i = vertical hydraulic gradient, in foot/foot (ft/ft). Using a conservative approach, a hydraulic gradient of 1 was assumed.

A= 685,654 ft^2. . Assumes the entire bottom of Company Lake leaks and the water elevation in the lake is 15.2 ft.

[Note: To convert from ft^3/s to gpd, multiply ft^3/s by 646,358.4.]

Because West Company Lake was backfilled with much higher hydraulic conductivity dredge spoils compared with native subsurface sediments, the remaining 304,000 gpd may be moving to groundwater horizontally through the west end of Company Lake. This conceptual model is supported by the similarity observed between fluoride concentrations in shallow groundwater at the west end of Company Lake to an average Company Lake surface water concentration (2.5 mg/L), and the higher fluoride concentrations observed in deeper groundwater that may be more representative of vertical seepage (21.5 mg/L).

Fluoride mass loading from Company Lake to groundwater was calculated using the water flux rate (Q) estimated above, with the average fluoride concentration measured in pond's surface water (2.5 mg/L) for horizontal leakage, and the average fluoride leachate concentration measured in pond sediments and process residue (21.5 mg/L) reported in *Technical Memorandum DS No. 17: Data Summary for the Wastewater Discharge Areas Addendum to the RI/FS Work Plan, Part 1* (CH2M HILL, December 12, 1997) for vertical leakage. Fluoride loading was estimated to be approximately 10 lb per day through vertical leakage and about 7.5 lb per day via horizontal leakage. These estimates are conservative (high) because they are based on conditions when maximum hydraulic gradients occur.

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ATTACHMENT A

Groundwater/Surface Water Interaction at South Ditch

Groundwater/Surface Water Interaction at South Ditch Reynolds Metals Company, Troutdale, Oregon

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Ken Trotman/CH2M HILL-SEA

DATE: May 26, 1998

Introduction

This memorandum summarizes the information available on the interaction between South Ditch and groundwater at the Reynolds Metals Company (RMC) site in Troutdale, Oregon. The South Ditch is the primary surface water drainage feature at the RMC facility, conveying stormwater, seasonal groundwater seepage, and facility wastewater to an elevation-activated pump station (see Figure A-1). The pump station discharges to Company Lake where it discharges through an outfall pipe into the Columbia River. An understanding of the surface water/groundwater relationship at the site provides information useful in interpreting site characterization data and in assessing remediation alternatives in the feasibility study. Specifically, this investigation focused on determining whether and at what point surface water in South Ditch flows out into groundwater.

Data Collection

The WDAA called for installation of piezometers along South Ditch and water elevation monitoring in surface water and groundwater to provide data to evaluate surface water/groundwater interaction in the vicinity of South Ditch.

Piezometer Installation

Sixteen temporary piezometers were installed at the locations indicated on Figure A-2 to provide shallow groundwater elevation data near the South Ditch. Where possible, nearby shallow monitoring wells were used to supplement the piezometer arrays to reduce the overall number of temporary piezometer installations. The piezometers were installed in arrays perpendicular to the ditch, to allow estimation of shallow hydraulic gradients on either side of the ditch. Soil boring and piezometer construction logs are provided at the end of this technical memorandum.

31-OCT-1997

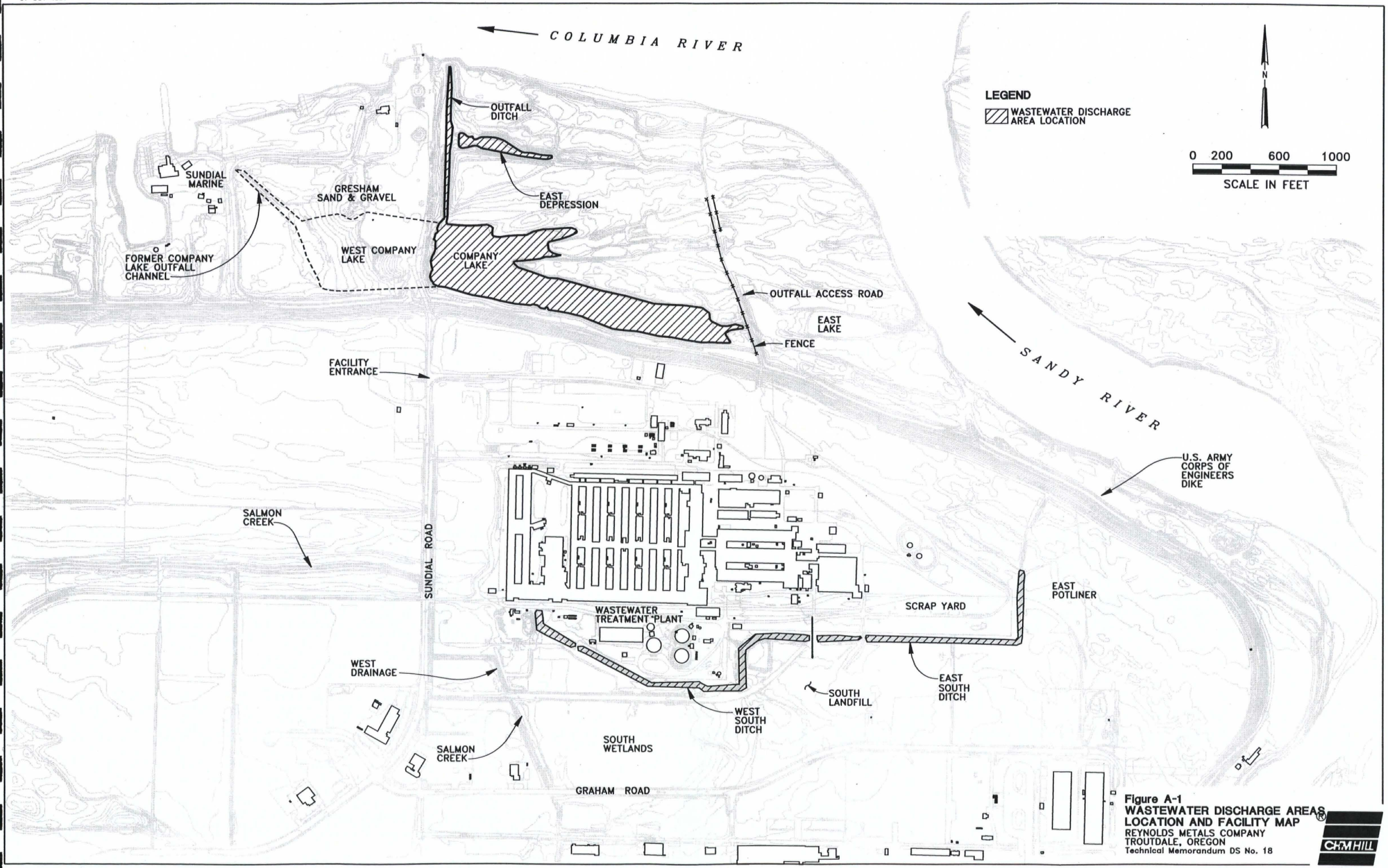

Figure A-1
WASTEWATER DISCHARGE AREAS LOCATION AND FACILITY MAP
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

9293CL35.DWG

12-MAY-1998

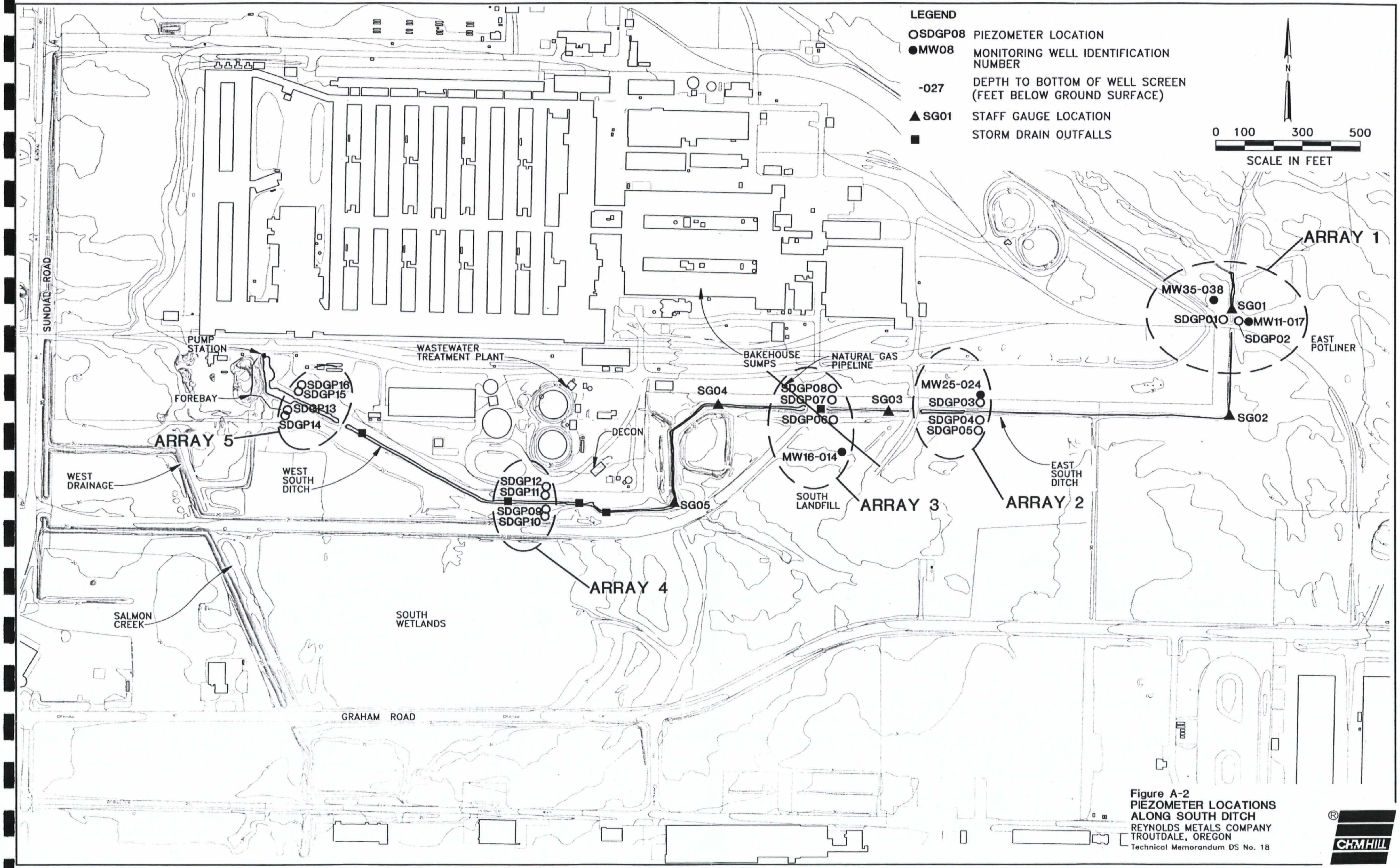

Figure A-2
PIEZOMETER LOCATIONS
ALONG SOUTH DITCH
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Technical Memorandum DS No. 18

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9293CL36.DWG

Water Elevation Monitoring

Weekly surface water and groundwater elevation data were collected at 8 staff gauges, 26 monitoring wells, the South Ditch pump station, and the 16 piezometers adjacent to South Ditch from the end of May through September 1997. Both wet (late winter/spring) and dry (late summer/fall) conditions are encompassed in this time period. Water elevation data are provided in Table A-1.

Dataloggers and pressure transducers were also used for a brief period (2 weeks) to collect surface water and groundwater data at a greater frequency during wet conditions. Manual water level elevations were measured twice daily for one week in September (during dry conditions). The electronic data and the manual water elevation data were plotted as hydrographs to evaluate surface water/groundwater interactions and to determine whether and at what point surface water in South Ditch seeps out of the ditch and into groundwater (becomes a losing ditch).

Precipitation data were obtained from the Bonneville Power Administration substation adjacent to the site for the same period groundwater data were collected: May through September 1997. The rainfall data are contained in Table A-2.

Results

Surface water influences shallow groundwater levels and flow in the vicinity of South Ditch. The degree of interaction differs with location and depth, depending on variations in subsurface permeability. The shallow soils in this portion of the site are a mixture of discontinuous interbedded sand and silt. This stratigraphic profile results in geographical differences in infiltration rates, differences in shallow groundwater drainage rates, and differences in the rate of response to seasonal change.

East South Ditch primarily carries surface water runoff and groundwater seepage during seasonal high water table conditions for only a portion of the year, and then goes dry. In contrast, the west South Ditch remains wet year-round because it receives permitted wastewater. Because of the difference in sources, results are presented separately for east South Ditch and west South Ditch.

An atypical discharge event occurred in September 1997 during the evaluation of the South Ditch interaction with groundwater. A long-term aquifer test was performed as part of the site characterization effort. During September, two production wells were pumped continuously at a constant rate. The volume of pumped water that exceeded plant demand was discharged into the west South Ditch, increasing the volume of flow in the ditch. The resulting higher than normal west South Ditch water level elevations provided an opportunity to evaluate the influence of a rapid change in surface water levels on groundwater.

East South Ditch

Three of the five piezometer arrays are located along east South Ditch. The first array, located in the upper reach of east South Ditch, consists of piezometers SDGP01 and SDGP02 and monitoring wells MW11-017 and MW35-038 (see Figure A-2). The hydrograph for this array (Figure A-3) shows:

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

Monitoring Wells

Well ID	MW01-019		MW02-012		MW02-034		MW03-017		MW03-098		MW03-175	
MPE [1] / SM	*28.25*	*S*	*31.10*	*S*	*30.64*	*UGS*	*29.69*	*S*	*30.65*	*IGS*	*30.72*	*DGS*
	Depth to Water [2]	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation
Date	*(feet BMP) [3]*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	8.90	19.35	8.04	23.06	9.43	21.21						
6/4/97	8.56	19.69	7.93	23.17	6.99	23.65	3.31	26.38	7.13	23.52	7.19	23.53
6/11/97	8.66	19.59	7.44	23.66	7.99	22.65	4.13	25.56	8.15	22.50	8.20	22.52
6/19/97	8.29	19.96	7.36	23.74	8.12	22.52	4.54	25.15	8.30	22.35	8.34	22.38
6/25/97	8.85	19.40	7.59	23.51	9.72	20.92	4.43	25.26	9.88	20.77	9.94	20.78
7/1/97	8.72	19.53	8.23	22.87	13.40	17.24	3.77	25.92	13.60	17.05	13.66	17.06
7/11/97	8.85	19.40										
7/16/97	8.99	19.26										
7/24/97	9.10	19.15	11.00	20.10	16.00	14.64						
7/30/97	9.21	19.04	11.44	19.66	17.37	13.27						
8/6/97	9.33	18.92	11.94	19.16	18.65	11.99	5.97	23.72	18.89	11.76	18.94	11.78
8/12/97	9.41	18.84										
8/21/97	9.47	18.78	12.63	18.47	18.88	11.76	6.13	23.56	19.08	11.57	19.15	11.57
8/26/97	9.48	18.77	12.79	18.31	19.33	11.31	5.97	23.72	19.49	11.16	19.54	11.18
9/2/97												
9/3/97	9.73	18.52	13.08	18.02	20.04	10.60	6.20	23.49	20.20	10.45	20.27	10.45
9/8/97			13.19	17.91	21.17	9.47	6.61	23.08	21.34	9.31	21.43	9.29
9/15/97	9.23	19.02	13.53	17.57	21.39	9.25	6.32	23.37	21.58	9.07	21.64	9.08
9/25/97	9.19	19.06	13.83	17.27	21.16	9.48	6.64	23.05	21.4	9.25	21.43	9.29

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

Monitoring Wells

Well ID	MW04-019		MW11-017		MW12-021		MW14-015		MW16-014		MW17-016		MW17-028		MW18-016	
MPE [1] / SM	*26.91*	*S*	*31.61*	*S*	*22.53*	*S*	*30.88*	*S*	*28.91*	*S*	*27.13*	*S*	*27.30*	*S/UGS*	*23.98*	*S*
	Depth to Water [2]	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation
Date	*(feet BMP)* [3]	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	9.52	17.39	6.04	25.57			5.86	25.02	7.37	21.54	8.96	18.17	9.08	18.22	8.14	15.84
6/4/97	9.40	17.51	5.94	25.67	5.46	17.07	8.73	22.15	7.31	21.60	8.05	19.08	8.22	19.08	7.90	16.08
6/11/97	9.35	17.56	5.84	25.77			5.44	25.44	7.25	21.66	8.44	18.69	8.61	18.69	8.13	15.85
6/19/97	9.61	17.30	6.07	25.54			5.29	25.59	7.10	21.81	8.57	18.56	8.70	18.60	7.42	16.56
6/25/97	9.61	17.30	6.16	25.45			5.91	24.97	7.41	21.50	8.95	18.18	9.09	18.21	8.33	15.65
7/1/97	10.04	16.87	6.44	25.17	7.04	15.49	6.11	24.77	7.46	21.45	9.14	17.99	9.29	18.01	8.15	15.83
7/11/97	10.59	16.32	6.68	24.93					7.53	21.38						
7/16/97	10.76	16.15	6.77	24.84					7.57	21.34						
7/24/97	11.17	15.74	7.08	24.53			6.90	23.98	7.67	21.24						
7/30/97	11.52	15.39	7.37	24.24					7.75	21.16						
8/6/97	12.10	14.81	7.74	23.87	9.31	13.22	7.41	23.47	7.87	21.04	11.69	15.44	11.94	15.36	9.90	14.08
8/12/97	11.80	15.11	8.04	23.57					7.96	20.95						
8/21/97	14.73	12.18							8.10	20.81	12.32	14.81	12.51	14.79		
8/26/97	12.21	14.70	8.80	22.81					8.14	20.77	12.26	14.87	12.41	14.89		
9/2/97					9.83	12.70										
9/3/97	12.27	14.64	8.98	22.63					8.28	20.63	12.51	14.62	12.61	14.69		
9/8/97	12.7	14.21	9.51	22.10					8.24	20.67	12.54	14.59	12.78	14.52		
9/15/97	13.35	13.56	9.93	21.68			8.53	22.35	8.29	20.62	12.52	14.61	12.70	14.60	10.59	13.39
9/25/97	12.37	14.54	10.02	21.59					8.33	20.58	12.38	14.75	12.57	14.73	9.86	14.12

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

c:\data\rmc\watlev\SD_SW\Sdwles2.xls\South Ditch WLEs

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

Monitoring Wells

Well ID	MW18-031		MW19-013		MW24-010		MW25-024		MW25-035		MW26-012		MW34-038	
MPE [1] / SM	*23.95*	*UGS*	*27.10*	*S*	*30.13*	*S*	*31.14*	*S*	*30.89*	*UGS*	*26.26*	*S*	*32.12*	*UGS*
	Depth to Water [2]	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation
Date	*(feet BMP)* [3]	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	3.29	20.66	7.12	19.98	7.76	22.37	8.06	23.08	9.68	21.21	4.53	21.73	10.67	21.45
6/4/97	1.11	22.84	7.09	20.01	7.66	22.47	7.63	23.51	7.26	23.63	3.80	22.46	7.84	24.28
6/11/97	1.90	22.05	6.98	20.12	7.44	22.69	7.42	23.72	8.22	22.67	4.20	22.06	9.18	22.94
6/19/97	1.93	22.02	6.82	20.28	7.27	22.86	7.38	23.76	8.48	22.41	4.31	21.95	8.14	23.98
6/25/97	3.44	20.51	7.14	19.96	7.48	22.65	7.82	23.32	9.97	20.92	4.80	21.46	11.15	20.97
7/1/97	6.98	16.97	7.13	19.97	7.77	22.36	8.48	22.66	13.66	17.23	4.13	22.13	15.64	16.48
7/11/97			7.23	19.87			9.55	21.59						
7/16/97			7.27	19.83			9.95	21.19						
7/24/97			7.33	19.77	8.60	21.53	10.39	20.75	16.26	14.63				
7/30/97			7.38	19.72	9.17	20.96	10.90	20.24	17.63	13.26				
8/6/97	12.41	11.54	7.45	19.65	9.37	20.76	11.58	19.56	18.89	12.00	6.56	19.70	20.62	11.50
8/12/97			7.50	19.60			11.91	19.23						
8/21/97			7.57	19.53			12.36	18.78	19.13	11.76				
8/26/97			7.60	19.50			12.58	18.56	19.58	11.31				
9/2/97														
9/3/97			7.74	19.36			12.98	18.16	20.37	10.52				
9/8/97			7.47	19.63			13.45	17.69	21.43	9.46				
9/15/97	15.21	8.74	7.43	19.67	10.41	19.72	13.88	17.26	21.65	9.24	7.33	18.93	22.96	9.16
9/25/97	15.22	8.73	7.39	19.71			14.33	16.81	21.41	9.48	7.22	19.04		

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

<u>SM = Screened material:</u>

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

	Monitoring Wells													
Well ID	**MW35-038**		**MW36-006**		**MW37-012**		**MW37-030**		**MW38-007**		**MW38-035**		**S. Ditch @ Pump**	
MPE [1] / SM	*31.56*	*UGS*	*21.68*	*S*	*21.48*	*S*	*21.32*	*UGS*	*22.56*	*S*	*23.07*	*UGS*	*21.87*	
	Depth to Water [2]	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**
Date	*(feet BMP) [3]*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	10.13	21.43	4.56	17.12	3.88	17.60	0.30	21.02	6.58	15.98	2.51	20.56		
6/4/97	7.34	24.22	4.21	17.47	3.27	18.21	TOC [4]		6.41	16.15	0.28	22.79		
6/11/97	8.65	22.91	4.30	17.38	3.40	18.08	TOC [4]		6.57	15.99	1.15	21.92		
6/19/97	7.60	23.96	4.10	17.58	3.37	18.11	TOC [4]		6.52	16.04	2.02	21.05		
6/25/97	10.56	21.00	4.48	17.20	3.85	17.63	0.80	20.52	6.72	15.84	2.72	20.35	7.15	14.72
7/1/97	14.90	16.66	4.69	16.99	4.59	16.89	4.34	16.98	6.61	15.95	6.15	16.92	6.73	15.14
7/11/97	7.00	24.56											5.72	16.15
7/16/97	17.04	14.52											6.81	15.06
7/24/97	17.22	14.34											6.78	15.09
7/30/97	18.81	12.75											6.70	15.17
8/6/97	19.94	11.62	7.04	14.64	7.74	13.74	9.77	11.55	7.35	15.21	11.44	11.63	6.35	15.52
8/12/97	20.52	11.04											6.07	15.80
8/21/97	20.02	11.54			7.83	13.65	9.83	11.49	7.50	15.06	11.46	11.61	6.69	15.18
8/26/97	20.60	10.96			7.72	13.76	10.28	11.04	7.56	15.00	11.94	11.13	6.72	15.15
9/2/97														
9/3/97	20.80	10.76			8.68	12.80	11.23	10.09	7.65	14.91	12.04	11.03	6.75	15.12
9/8/97	22.22	9.34			8.76	12.72	12.45	8.87	7.67	14.89	14.04	9.03	7.12	14.75
9/15/97	22.37	9.19	7.42	14.26	9.16	12.32	12.63	8.69	7.72	14.84	14.22	8.85	4.71	17.16
9/25/97	21.98	9.58			8.07	13.41	12.55	8.77	7.79	14.77	14.20	8.87	6.77	15.10

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

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DGS = Deep well screened in sand.

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

Piezometers														
Well ID	**SDGP01**		**SDGP02**		**SDGP03**		**SDGP04**		**SDGP05**		**SDGP06**		**SDGP07**	
MPE [1] / SM	*28.46*	*S*	*29.17*	*S*	*28.59*	*S*	*29.2*	*S*	*28.80*	*S*	*28.11*	*S*	*28.49*	*S*
	Depth to Water [2]	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**
Date	*(feet BMP) [3]*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	5.53	22.93	7.03	22.14	5.98	22.61	6.59	22.61	6.17	22.63	7.11	21.00	7.54	20.95
6/4/97	5.10	23.36	5.52	23.65	5.33	23.26	6.10	23.10	5.77	23.03	7.11	21.00	7.31	21.18
6/11/97	4.25	24.21	5.69	23.48	5.26	23.33	6.06	23.14	5.64	23.16	7.02	21.09	7.20	21.29
6/19/97	3.90	24.56	4.07	25.10	5.13	23.46	5.95	23.25	5.51	23.29	7.11	21.00	7.10	21.39
6/25/97	4.31	24.15	4.13	25.04	5.84	22.75	6.58	22.62	6.16	22.64	7.16	20.95	7.17	21.32
7/1/97	5.80	22.66	4.56	24.61	6.79	21.80	7.78	21.42	7.31	21.49	7.19	20.92	8.25	20.24
7/11/97	7.46	21.00	5.35	23.82	8.20	20.39	8.83	20.37	8.35	20.45	7.23	20.88	9.23	19.26
7/16/97	7.63	20.83	5.67	23.50	8.69	19.90	9.12	20.08	8.73	20.07	7.25	20.86	9.68	18.81
7/24/97	8.40	20.06	5.94	23.23	9.22	19.37	9.50	19.70	9.06	19.74	7.30	20.81	9.92	18.57
7/30/97	8.82	19.64	6.25	22.92	9.88	18.71	9.62	19.58	10.01	18.79	7.40	20.71	10.31	18.18
8/6/97	9.49	18.97	6.74	22.43	10.47	18.12	10.83	18.37	10.38	18.42	7.46	20.65	10.95	17.54
8/12/97	9.92	18.54	7.02	22.15	10.82	17.77	11.21	17.99	10.76	18.04	7.55	20.56	11.21	17.28
8/21/97	10.46	18.00	7.42	21.75	11.13	17.46	11.53	17.67	11.09	17.71	7.67	20.44	11.55	16.94
8/26/97	10.66	17.80	7.59	21.58	14.92		11.63	17.57	11.18	17.62			11.55	16.94
9/2/97														
9/3/97	10.82	17.64	7.68	21.49	15.01		11.68	17.52	11.07	17.73	7.78	20.33	11.62	16.87
9/8/97	11.35	17.11	8.24	20.93	12.41	16.18	12.52	16.68	12.06	16.74	7.81	20.30	11.81	16.68
9/15/97	11.77	16.69	8.56	20.61	14.95	13.64	12.91	16.29	12.46	16.34	15.09	13.02	13.83	14.66
9/25/97	12.09	16.37	8.61	20.56	13.12	15.47	12.94	16.26	12.48	16.32	15.05	13.06	11.81	16.68

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

Piezometers														
Well ID	**SDGP08**		**SDGP09**		**SDGP10**		**SDGP11**		**SDGP12**		**SDGP13**		**SDGP14**	
MPE [1] / SM	*28.83*	*S*	*21.51*	*S*	*21.84*	*S*	*22.65*	*S*	*24.07*	*S*	*22.49*	*S*	*22.27*	*S*
	Depth to Water [2]	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation	Depth to Water	Water Level Elevation
Date	*(feet BMP)* [3]	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	*(feet)*
5/29/97	7.86	20.97	3.24	18.27	3.82	18.02	4.23	18.42	5.65	18.42	6.71	15.78	5.49	16.78
6/4/97	7.53	21.30	2.91	18.60	3.31	18.53	3.69	18.96	5.15	18.92	6.63	15.86	5.27	17.00
6/11/97	7.37	21.46	2.60	18.91	3.38	18.46	3.80	18.85	5.20	18.87	6.47	16.02	5.18	17.09
6/19/97	6.62	22.21	3.23	18.28	3.30	18.54	4.02	18.63	5.30	18.77	6.51	15.98	5.36	16.91
6/25/97	7.60	21.23	2.72	18.79	3.79	18.05	3.83	18.82	5.53	18.54	6.41	16.08	5.40	16.87
7/1/97	8.67	20.16	4.46	17.05	4.10	17.74	4.71	17.94	6.04	18.03	6.45	16.04	5.82	16.45
7/11/97	9.40	19.43	4.79	16.72	5.31	16.53	5.58	17.07	6.73	17.34	6.59	15.90	6.61	15.66
7/16/97	9.73	19.10	4.98	16.53	5.65	16.19	5.79	16.86	6.93	17.14	6.61	15.88	6.82	15.45
7/24/97	10.00	18.83	5.17	16.34	5.97	15.87	6.06	16.59	7.19	16.88	6.66	15.83	7.09	15.18
7/30/97	10.40	18.43	5.13	16.38	6.44	15.40	6.45	16.20	7.53	16.54	6.71	15.78	7.44	14.83
8/6/97	11.04	17.79	5.30	16.21	7.12	14.72	7.03	15.62	8.00	16.07	6.75	15.74	8.00	14.27
8/12/97	11.37	17.46	5.40	16.11	7.33	14.51	7.22	15.43	8.19	15.88	6.77	15.72	7.87	14.40
8/21/97	11.35	17.48	5.53	15.98	7.40	14.44	7.30	15.35	8.29	15.78	6.81	15.68	7.89	14.38
8/26/97	14.38		5.49	16.02	7.33	14.51	7.28	15.37	8.28	15.79	6.83	15.66	7.82	14.45
9/2/97														
9/3/97	14.16		5.34	16.17	7.21	14.63	7.19	15.46	8.54	15.53	6.82	15.67	7.97	14.30
9/8/97	11.93	16.90	5.27	16.24	7.89	13.95	7.58	15.07	8.39	15.68	6.87	15.62	8.47	13.80
9/15/97	14.3	14.53	5.11	16.40	8.06	13.78	7.70	14.95	8.42	15.65	6.91	15.58	8.79	13.48
9/25/97	12.27	16.56	5.03	16.48	7.55	14.29	7.34	15.31	8.17	15.90	6.88	15.61	7.68	14.59

Notes:

[1] MPE = Measuring point elevation; in feet, NGVD 1929.

[2] Depth to water is measured in feet below the measuring point elevation.

[3] BMP = below measuring point elevation.

[4] TOC = Water level above top of casing.

[5] MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

Table A1
South Ditch Manual Water Level Data Summary (May 1997 through September 1997)
Reynolds Metals Company - Troutdale, Oregon

	Piezometers				**Staff Gauges**									
Well ID	**SDGP15**		**SDGP16**		**Columbia River [5]**		**SG01**	**SG02**	**SG03**	**SG04**	**SG05**	**SG06**	**SG07**	**SG08**
MPE [1] / SM	*23.21*	*S*	*24.30*	*S*	*32.63*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
	Depth to Water [2]	**Water Level Elevation**	**Depth to Water**	**Water Level Elevation**	**Depth to Water**	**Elevation**	**Elevation**							
Date	*(feet BMP) [3]*	*(feet)*	*(feet BMP)*	*(feet)*	*(feet BMP)*	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)
5/29/97	7.39	15.82	8.27	16.03			25.20	25.52	21.38	18.96	18.42	16.40	15.76	15.30
6/4/97	7.23	15.98	8.16	16.14	7.83	24.80	25.43	25.58	21.44	18.40	18.04	16.72	15.87	15.31
6/11/97	7.28	15.93	8.11	16.19	9.77	22.86	25.30	25.54	21.42	18.40	19.18	16.56	15.82	15.22
6/19/97	7.32	15.89	8.10	16.20			25.16	25.44	21.56	18.53	18.32	15.89	15.72	15.02
6/25/97	7.44	15.77	8.29	16.01	12.03	20.60	25.16	25.36	21.76	18.50	18.25	16.34	15.80	15.08
7/1/97	7.61	15.60	8.42	15.88	18.65	13.98	25.19	25.26	21.40	18.50	18.30	16.45		15.50
7/11/97	7.74	15.47	8.86	15.44	19.44	13.19	25.12	25.00	21.45	18.39	18.15	16.41	15.75	14.80
7/16/97	7.94	15.27	8.92	15.38	19.04	13.59	Dry	24.76	21.34	18.38	18.14	Dry	Dry	14.65
7/24/97	8.03	15.18	9.02	15.28	20.10	12.53	Dry	Dry	21.29	18.38	18.17	Dry	Dry	14.40
7/30/97	8.19	15.02	9.21	15.09	22.21	10.42	Dry	Dry	Dry	18.37	18.18	Dry	Dry	14.16
8/6/97	8.40	14.81	9.50	14.80	21.91	10.72	Dry	Dry	Dry	18.36	18.22	Dry	Dry	14.46
8/12/97	8.73	14.48	9.51	14.79			Dry	Dry	Dry	18.37	18.24	Dry	15.93	14.46
8/21/97	8.39	14.82	9.56	14.74	22.35	9.53	Dry	Dry	Dry	18.37	18.28	Dry	Dry	14.55
8/26/97	8.31	14.90	9.38	14.92	23.25	8.63	Dry	Dry	Dry	18.56	18.47	Dry	Dry	14.71
9/2/97														
9/3/97	8.65	14.56	9.76	14.54	23.41	8.47	Dry	Dry	Dry	18.32	18.16	Dry	Dry	14.34
9/8/97	8.56	14.65	9.80	14.50			[6] NM	Dry	Dry	19.08	19.08	Dry	Dry	14.27
9/15/97	8.40	14.81	9.90	14.40	25.46	6.42		Dry	Dry	19.09	19.09	Dry	Dry	14.29
9/25/97	8.82	14.39	9.92	14.38				Dry	Dry	19.05	19.05	Dry	Dry	14.34

Notes:

1 MPE = Measuring point elevation; in feet, NGVD 1929.

2 Depth to water is measured in feet below the measuring point elevation.

3 BMP = below measuring point elevation.

4 TOC = Water level above top of casing.

5 MPE for Columbia River changed from 32.63 to 31.88 feet on 8/15/97. MPE changed from 31.88 feet to 30.90' in 10/97.

6. NM = Not measured because SG01 was removed on 9/8/97.

SM = Screened material:

S = Silt

UGS = Upper portion of gray sand unit.

IGS = Intermediate-depth well screened in gray sand

DGS = Deep well screened in sand.

Table A-2
Precipitation Data

Date	Inches of Precipitation
5/29/97	**0.28**
5/30/97	0.01
6/6/97	1.19
6/12/97	0.46
6/13/97	trace
6/23/97	0.50
6/24/97	0.11
6/30/97	0.81
7/1/97	0.57
7/2/97	0.01
7/9/97	0.78
7/10/97	0.06
7/11/97	0.08
7/18/97	0.05
8/21/97	0.47
8/27/97	1.05
8/28/97	0.11
9/10/97	0.13
9/11/97	0.09
9/12/97	trace
9/16/97	0.66
9/17/97	0.35
9/19/97	0.43
9/29/97	0.55
9/30/97	0.01

On dates not shown, no precipitation occurred.

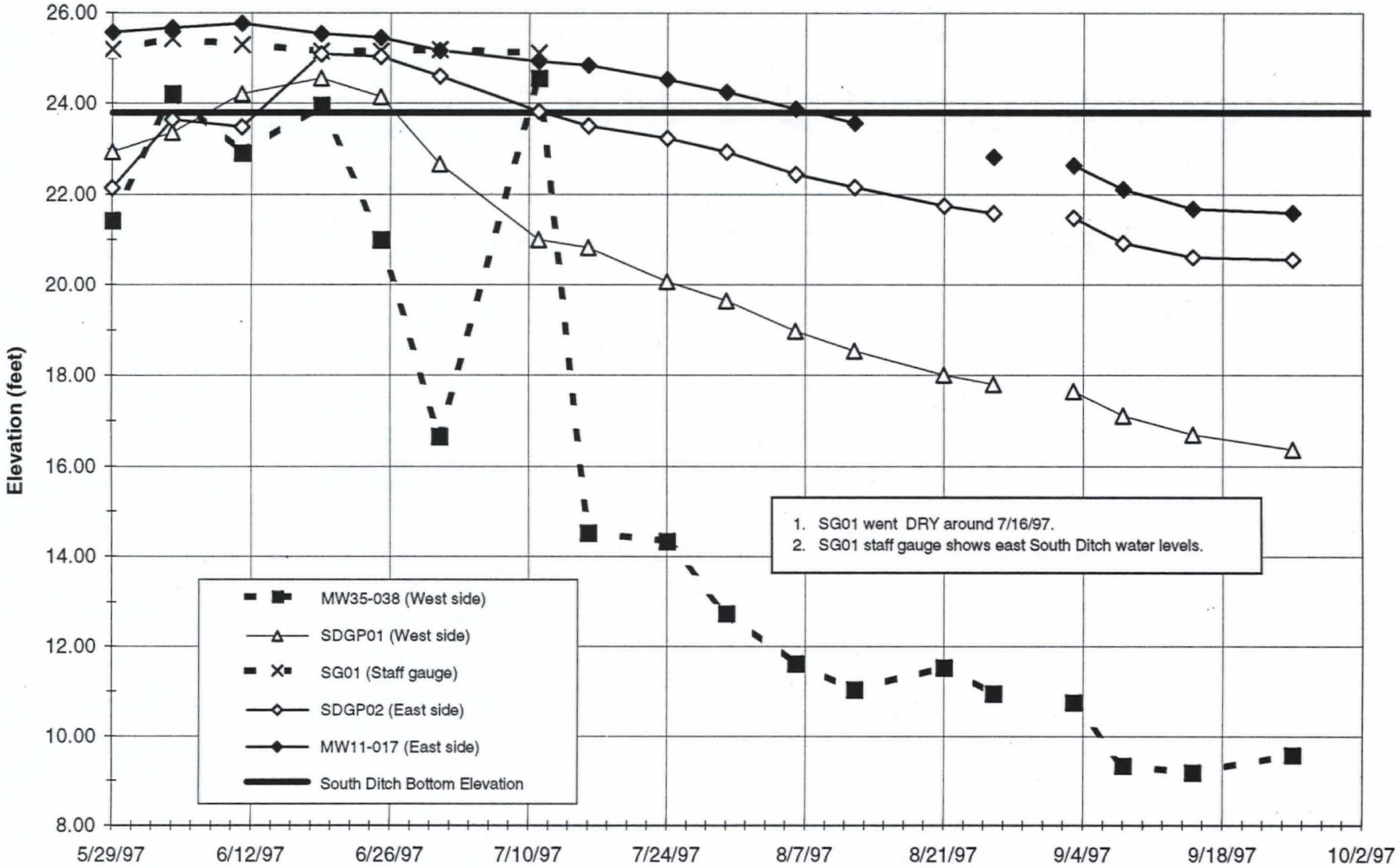

Figure A-3
East South Ditch Groundwater Elevations at Array 1
Reynolds Metals Company
Troutdale, Oregon
Technical Memorandum DS No. 18

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Printed 5/27/98

- Groundwater elevations in the piezometers remaining at or below the surface water elevations in the ditch.
- Groundwater elevations in MW11-017 remaining slightly above the surface water elevation in the ditch until mid-July, and groundwater elevations in MW35-038 rarely rising above the bottom elevation of the ditch during this same period.
- Groundwater elevations in MW35-038 decrease at a faster rate, during the late June to early July time period, than other groundwater monitoring points. The 8-foot increase in the MW35-038 water level on July 12, 1997, appears to be anomalous.

The trend observed in MW11-017 is typical of silt wells (MW16-014, MW19-013, MW26-012) located in the southern portion of the RMC site. This difference in response between MW11-017 and the piezometers and MW35-038 is likely because the piezometers and MW35-038 are screened at greater depths (approximately 11 and 20 feet, respectively, below the bottom elevation of the ditch) than MW11-017. MW11-017 is screened in a sand containing about 25 percent silt, with the top of its screen about 1.5 feet below the bottom elevation of the ditch. Because MW11-017 is screened at a shallower elevation, the water levels likely reflect the seasonal decline of very shallow groundwater, also reflected by the South Ditch water levels. The degree of hydraulic connection is likely greater between the ditch and MW11-017 versus the other piezometers and MW35-038.

In June, groundwater levels in MW11-017 are very close to surface water elevations; comparing the groundwater levels to the adjusted surface water levels indicates groundwater is discharging to the ditch. MW11-017 groundwater elevations begin to drop below the water level in the ditch in early July. At this time, surface water in this portion of the ditch recharges groundwater for a short period of time until the ditch goes dry in mid-July. By early August, groundwater levels have dropped below the bottom elevation of the ditch, and any recharge to groundwater (surface water leakage out of the ditch into groundwater) would occur only from late summer precipitation events (see Figure A-3). The ditch would again become a groundwater discharge point (groundwater flowing into the ditch) sometime in the winter once groundwater levels rise above surface water levels. Review of 1997–98 monthly water level data indicates groundwater elevations exceeding surface water elevations (groundwater flowing into the ditch) in early February 1998 at array 1.

The second piezometer array is located southeast of the bakehouse. Figure A-4 shows:

- Adjusted staff gauge SG03 water levels. Staff gauge SG03 is the closest gauge for this array, but direct readings do not reflect surface elevations at the piezometer array. Therefore, surface water measurements were adjusted by the difference in channel bottom elevations between the SG03 location and the piezometers.
- Groundwater levels in piezometers SDGP03, SDGP04, SDGP05, and monitoring well MW 25-024 respond at similar rates on both sides of the ditch. All four locations are screened at about the same elevation in the same material (silt or silty sand).

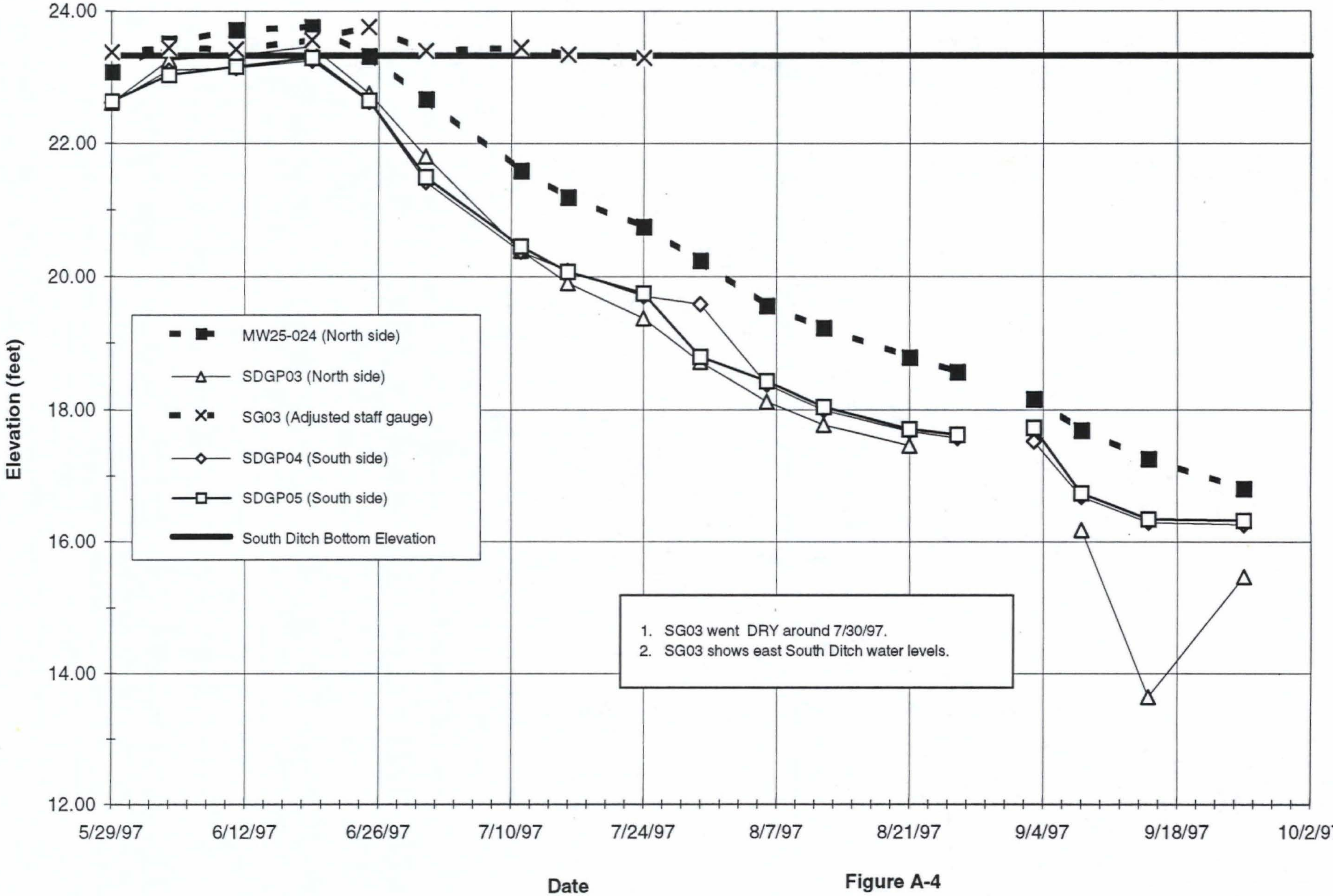

Figure A-4
East South Ditch Groundwater Elevations at Array 2
Reynolds Metals Company
Troutdale, Oregon
Technical Memorandum DS No. 18

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- From the end of May through July, surface water levels at this location are shallow (approximately 0.5 foot or less) in the ditch. During this period the ditch recharges groundwater. By early August, the ditch has gone dry and there is no longer any influence on groundwater.

On the basis of 1997-98 monthly water level data, it appears this portion of the ditch receives very little groundwater discharge in the spring. Conversely, the period of groundwater recharge is relatively short; it occurs between the time when groundwater levels have dropped below surface water levels and when the ditch dries out. The surface water and groundwater levels appear to be closely associated during the wetter times of the year in this portion of the ditch.

The hydrograph of groundwater levels from array 3 (Figure A-5) illustrates the effects of the stratigraphic variability on the shallow groundwater flow system. To more accurately represent the surface water elevation in the ditch at the location of the array, surface water elevations at staff gauge SG03 were adjusted. Figure A-5 shows:

- Decreasing groundwater levels at all four monitoring locations. However, the rate of decrease varies greatly with groundwater levels dropping more rapidly at monitoring points on the north side of the ditch. The north side groundwater levels (SDGP07 and SDGP08) drop below the ditch water level by early July and continue to decline at 1 to 2 feet per month throughout the summer. The reason for the precipitous drop in the north side piezometer water level measurements on September 15 is unknown.

- On the south side of the ditch, groundwater levels in SDGP06 and MW16-014 decline much more slowly through the summer. The steep drop observed in SDGP06 water levels on September 15 did not recover in the following measurement as did the piezometers on the north side of the ditch. The reason for this drop is also not known.

- The difference in response can likely be attributed to differences in the permeabilities of the materials screened and, related to that, the degree of hydraulic connection between the ditch and groundwater. The north side piezometer water level decline is typical of the seasonal decline observed in other shallow wells. The much more shallow decline observed in the south side well (MW16-014) could indicate a greater degree of hydraulic connection to the ditch due to the shallower placement of the well screen in more permeable sands. As a result, this monitoring point matches surface water elevations more closely. Alternatively, the slower decline in groundwater elevations observed in SDGP06 and MW16-014 on the south side of the ditch could be the result of screens completed in a localized perched groundwater zone where much slower drainage occurs during the summer months.

Because of the variability of groundwater response on each side of the ditch, it is difficult to estimate what time of the year groundwater starts to discharge to the ditch. However, the higher groundwater levels on the south side of the ditch in SDGP06 and MW16-014 suggest the potential for year-round groundwater discharge into the ditch at this location.

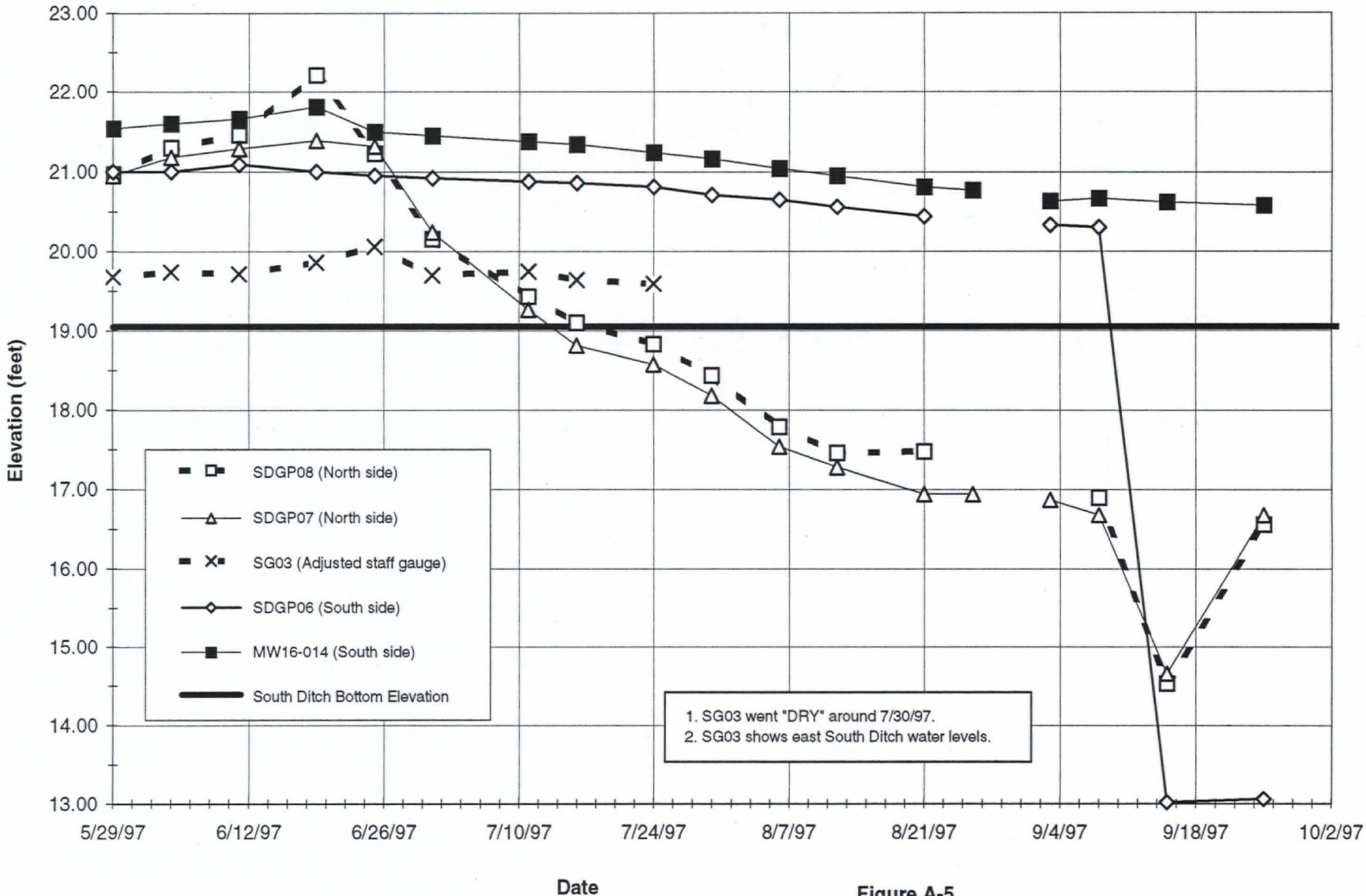

Figure A-5
East South Ditch Groundwater Elevations at Array 3
Reynolds Metals Company
Troutdale, Oregon
Technical Memorandum DS No. 18

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West South Ditch

The two remaining piezometer arrays occur along west South Ditch (see Figure A-2). Figure A-6 depicts general downward trends in groundwater levels at array 4 in response to a seasonal groundwater decline. The hydrograph shows:

- The rate of decline is similar in all four piezometers which are screened in silt at about the same elevation.
- Near mid-July, a transition period occurs and west South Ditch changes from a gaining to a losing ditch (surface water recharges groundwater) as groundwater levels drop below surface water levels in the ditch.

Groundwater levels (with the exception of SDGP10) remain above the bottom elevation of the ditch for the entire monitoring period. Because west South Ditch receives wastewater from the facility during the dry season, it does not go dry. Therefore, this portion of the ditch continues to recharge groundwater throughout the summer and early fall months.

Figure A-6 also shows the surface water elevation in the ditch increasing in early September in response to an increase in discharge to the ditch at an upstream outfall. An aquifer test, which began on September 4, 1997, was the source of the additional discharge. Groundwater levels appear to be slightly increased in late August prior to the startup of the aquifer test. As noted in Table A-2, there were three days of rainfall during the middle of August which might have produced the slight increase in shallow groundwater levels.

With the exception of SDGP 10 and 11, groundwater levels show a dampened response to the increasing surface water level trend following startup of the aquifer test. The downward trend in groundwater levels in SDGP 10 and 11 on September 8 is unexplained. The drop does not appear to be related to pumping influences because water levels increase in SDGP 10 and 11 prior to shutting off the pumps. In addition, the increase in groundwater levels near the end of September does not appear to be related to river stage; the river stage was relatively constant during mid- to late September.

The final piezometer array is located at the mouth of the pump station forebay. Figure A-7 shows the general downward trends in groundwater levels in response to a seasonal groundwater decline. The rate of decline is similar in three of the four piezometers. Piezometer SDGP13, located on the south side nearest the ditch, appears to decline more slowly than the other three piezometers. All four piezometers are screened in silt with 15 to 25 percent sand at about the same elevation. The slower decline in SDGP13 water levels is similar to the declines observed in SDGP06 and MW16-014. This trend could indicate a good hydraulic connection to the ditch, or alternatively, it could be the results of the screen being completed in a localized perched zone where slower drainage occurs during the summer.

Because an elevation-activated pump regulates surface water levels in the collection forebay, it is difficult to pinpoint the transition period when this portion of the west South Ditch changes from a gaining to a losing ditch. It appears the transition occurs sometime in July, as groundwater levels in three of the piezometers (except SDGP13) drop below the average surface water level in the ditch. Direct hydraulic connection between surface water and

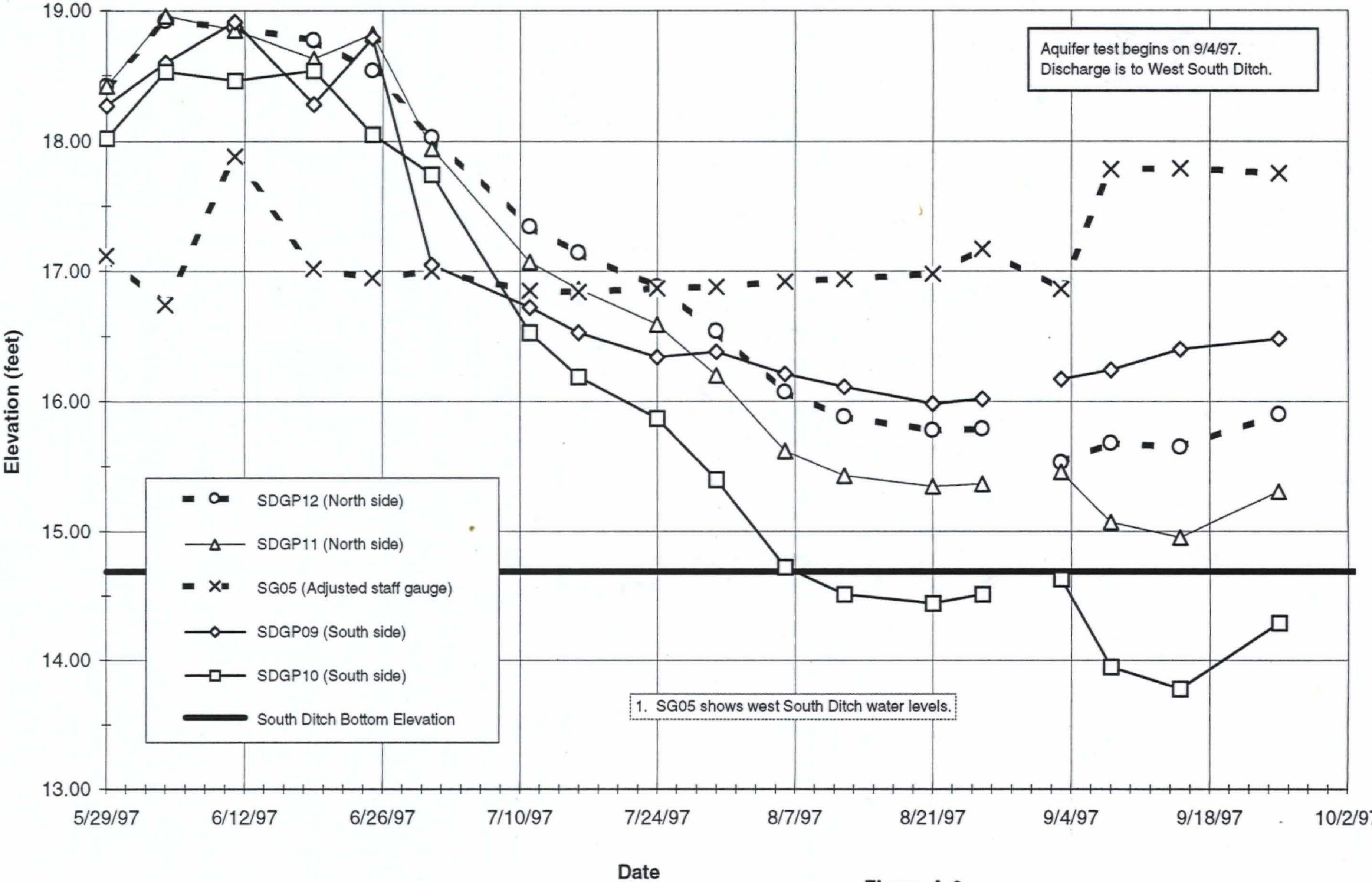

Figure A-6
West South Ditch Groundwater Elevations at Array 4
Reynolds Metals Company
Troutdale, Oregon
Technical Memorandum DS No. 18

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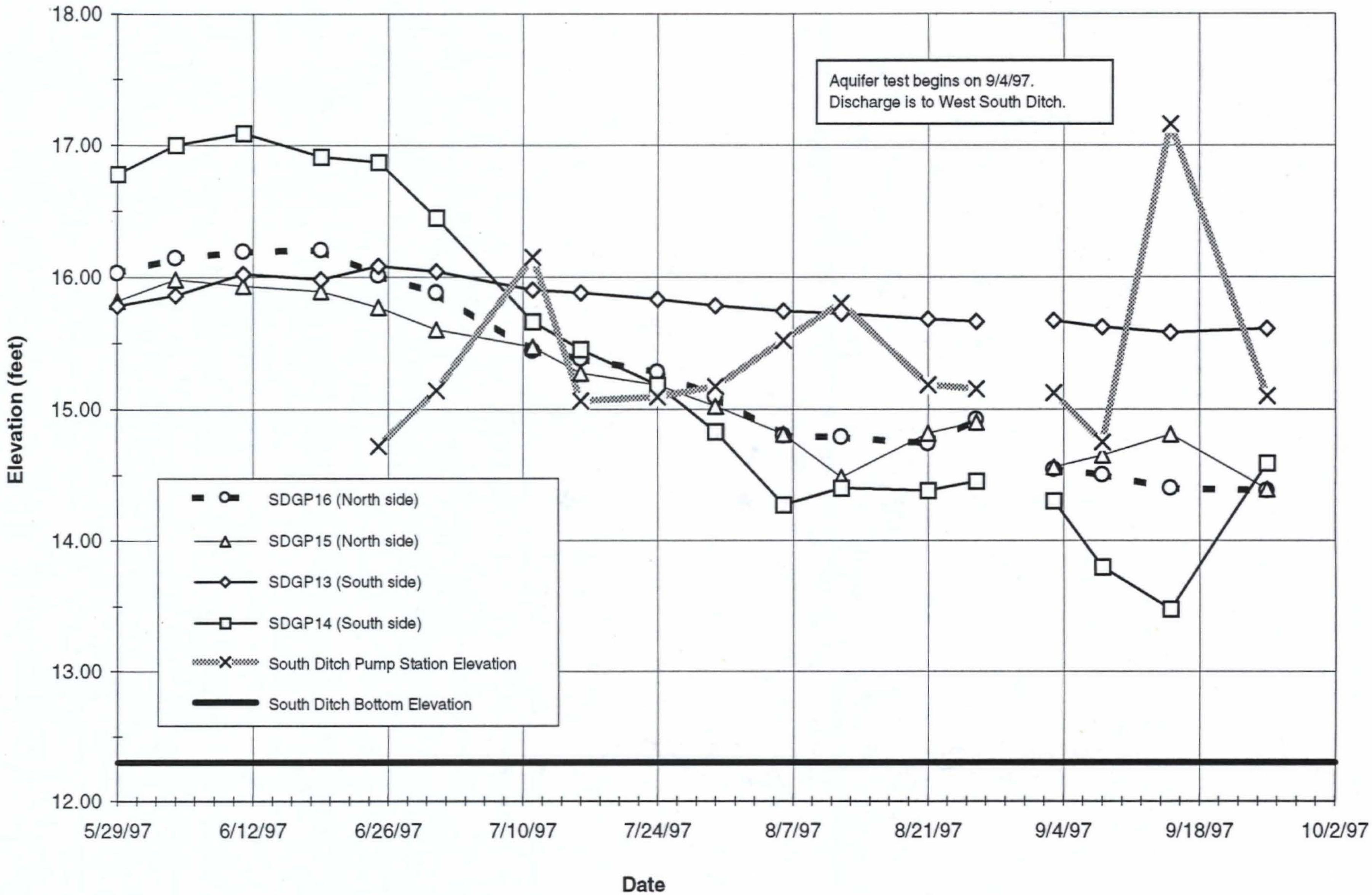

Figure A-7
West South Ditch Groundwater Elevations at Array 5
Reynolds Metals Company
Troutdale, Oregon
Technical Memorandum DS No. 18

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Printed 5/27/98

groundwater is maintained year-round because groundwater levels remain above the bottom elevation of the ditch and the ditch receives stormwater and wastewater from outfalls located upstream.

Groundwater/Surface Water Interactions

East South Ditch

East South Ditch primarily carries surface water runoff and groundwater seepage during seasonal high water table conditions and is a groundwater discharge point (a gaining ditch) until the end of June. For the month of July, as groundwater levels drop but the ditch still contains water, it becomes a losing ditch, recharging groundwater for a short period (2 to 4 weeks). By early August, the ditch has gone dry and there is little to no influence on groundwater. Only runoff from late summer precipitation events could provide recharge to groundwater at this time. Because the period when the ditch is recharging to groundwater is short and this portion of the ditch does not receive process water, constituent migration from east South Ditch to groundwater is expected to be minimal.

West South Ditch

Groundwater and surface water data collected in 1997 indicate west South Ditch is a gaining ditch during the wet season until the end of June. Around the end of June to mid-July, a transition period occurs and west South Ditch changes from a gaining to a losing ditch (recharging groundwater) as groundwater levels drop below surface water levels in the ditch. Because this portion of the ditch receives permitted stormwater and wastewater from several outfalls, the ditch does not go dry. This portion of the ditch continues to recharge groundwater throughout the summer and early fall.

An order-of-magnitude flux (seepage rate) was estimated for west South Ditch during late summer conditions using Darcy's equation:

$$Q = KiA$$

where:

Q = quantity of flow per unit time, in cubic feet per second (ft^3/s) (i.e., seepage flow through bottom and sides of ditch).

K = hydraulic conductivity, in feet per second (ft/s). Hydraulic conductivity values ranged from 3×10^{-09} ft/sec to 3×10^{-07} ft/sec based on the presence of silt or of silt interbedded with thin layers of silty sand observed during piezometer installation.

i = approximate vertical hydraulic gradient, in foot/foot (ft/ft). An approximate vertical hydraulic gradient was estimated by subtracting the average groundwater elevation at array 4 from the average adjusted surface water elevation at SG05 during the dry season and dividing by the difference between the ditch bottom elevation and the average mid-screen elevation of the piezometers comprising array 4; i = 0.164 ft/ft .

A= estimated cross-sectional area of the West South Ditch channel through which groundwater flow occurs (ft^2). Assumes an average ditch width of 20 feet with wetted sides of 1.4 feet each. The wet portion of the ditch is approximately 2,070 feet long; A= 47,196 ft^2.

The flux estimate is primarily a vertical seepage calculation; however, the seepage area of the ditch was increased to account for some horizontal leakage out the sides of the ditch. This is a conservative estimate because it is based on late summer conditions when groundwater is at its seasonal low and vertical hydraulic gradients are greatest. The results of the flux estimate are presented in Table A-3 as a range based on different assumed hydraulic conductivities.

Table A-3
Estimated West South Ditch Flux and Load During Period of Maximum Seepage

Description of K Value	Hydraulic Conductivity (ft/s)[1]	Flux (ft^3/sec)	Flux (gpd)	Estimated Fluoride Load (lb/day)[2]	Rationale for Selection of K Value
Maximum	$3x10^{-07}$	$2x10^{-03}$	1,293	0.1 to 0.2	Based on presence of silt interbedded with thin layers of silty sand
Best Professional Judgment	$3x10^{-08}$	$2x10^{-04}$	129	0.01 to 0.02	Based on presence of silt containing 5 - 20% sand (also similar to conductivity measured for Company Lake sediment)
Minimum	$3x10^{-09}$	$2x10^{-05}$	13	0.001 to 0.002	Based on presence of silt

[1] From Freeze and Cherry (1979).
[2] Range calculated from average fluoride surface water concentration (11 mg/L) in west South Ditch (PRC, 1993) and estimated fluoride concentration seeping to groundwater from Company Lake (CH2M HILL, December 1997).

Because the estimated flux through west South Ditch is small, the contribution of surface water to groundwater is minimal. On the basis of the calculated flux rates, fluoride loading from west South Ditch to groundwater was estimated based on surface water concentrations and potential concentrations seeping to groundwater. During the period of maximum seepage when groundwater is at its seasonal low elevation, the estimated fluoride loading from west South Ditch to groundwater is very small, less than a pound per day (see Table A-3). During the transitional periods, when groundwater elevations are declining, and vertical hydraulic gradients are less than maximum, fluoride loading would be even less.

Summary

Groundwater elevations across the site, and along South Ditch, show a downward trend between May 29 and September 25, 1997, reflecting a seasonal decline in the water table as summer progresses.

East South Ditch, which does not receive wastewater discharges, becomes a losing ditch for a very brief period of 2 to 4 weeks during the year. During this period the ditch provides recharge to groundwater until it goes dry. This seasonal pattern of the ditch drying up appears to be consistent from year to year. Because east South Ditch goes dry about the time groundwater levels drop, the constituent migration from east South Ditch to groundwater is expected to be minimal.

West South Ditch becomes a losing ditch around the end of June to mid-July, as groundwater levels drop below surface water levels in the ditch. Because this portion of the ditch receives stormwater, process water, and wastewater from several outfalls, the ditch does not go dry and continues to recharge groundwater throughout the summer and early fall. The best estimated order-of-magnitude flux through the bottom and sides of west South Ditch during dry season conditions is 2×10^{-04} ft^3/sec (or approximately 129 gpd). Based on a potential range of hydraulic conductivities that could be present in the material along the ditch walls/bottom, the flux could range from 2.56×10^{-05} ft^3/sec (or approximately 13 gpd) to 2×10^{-3} ft^3/sec (1,293 gpd). Because leakage out of west South Ditch is small, the potential for surface water constituents to impact to groundwater is low. The estimated loss of fluoride to groundwater during the period of maximum seepage is less than 1 lb/day.

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	
107493.B6.φ2	SDGPφ1	1	OF 1

SOIL BORING LOG

MPE =
GSE =

PROJECT RMC - TROUTDALE
LOCATION ≈ 12 FT W. OF S. DITCH BY EPL
ELEVATION
DRILLING CONTRACTOR GEOTECH
DRILLING METHOD AND EQUIPMENT GEOPROBE
L06Q38 = OWRD START CARD
WATER LEVELS
START 5-19-97 FINISH 5-19-97 LOGGER GALL/KREKOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
φ					0-1 FT: LSI FILL	3/4" O.D.
						SCH. 80 RISER
5	]		1.3		SILT (ML), LT. OLIVE GRAY (5Y 5/2), DAMP, MED. STIFF, MOTTLED ORANGE-BRN. 5% V. FINE SAND	
						BENT. GRANULES
10	]		1.0		SILT W/SAND (OLIVE GRAY (5Y 3/2)), WET, 15-20% V. FINE SAND, SOFT	
						10/20 SAND
15	]		φ		NO RECOVERY	
					SILT W/SAND, AS ABOVE	0.010-INCH SLOT
20	]		1.8			STAINLESS STEEL PT.

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
107493.~~DB~~.ϕ2	SDGPϕ2	SHEET 1 OF 1

SOIL BORING LOG

GSE =
MPE =

PROJECT RMC - TROUTDALE LOCATION ≈40 FT W. OF MW11-017

ELEVATION ______ DRILLING CONTRACTOR GEOTECH EXPLORATIONS

DRILLING METHOD AND EQUIPMENT GEOPROBE ; SUNNY 75°F L06037 OWRD START CARD

WATER LEVELS ______ START 5-19-97 FINISH 5-19-97 LOGGER GALL/KREKO

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
ϕ					0-1 FT: LSI FILL, SAND, SILT, PEBBLES, COBBLES	6" STICKUP RUBBER CAP SCH. 80 PVC
5	]		1.8		SILT (ML), LIGHT OLIVE GRAY (5Y 5/2), MED. STIFF, MOTTLED ORANGE-BROWN, 5% V. FINE SAND, DAMP	
1ϕ	]		1.4		SILT (ML), w/SAND, OLIVE GRAY (5Y 3/2), DAMP, 15-20% V. FINE SAND, SOFT	↑ BENTONITE GRANULES
15	]		ϕ		NO SAMPLE RECOVERY - WET	10/20 SILICA SAND ↓ 0.010-INCH SLOTS 15-20 FT BGS
2ϕ	]		ϕ		NO SAMPLE RECOVERY LIKELY FLOWING SILT W/SAND (SEE MW34 & 35 LOGS), WET	STAINLESS STEEL POINT
25						

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
107493.B6.φ2	SDGPφ3	SHEET 1 OF 1

SOIL BORING LOG

GSE = 28.2'
MPE = 28.59'

PROJECT RMC - TROUTDALE LOCATION ≈25 FT S. OF MW25-024

ELEVATION ______ DRILLING CONTRACTOR GEO TECH

DRILLING METHOD AND EQUIPMENT GEO-PROBE - GH-40 - OWRD START CARD # = Lφ6φ39

WATER LEVELS ______ START 5-19-97 FINISH 5-19-97 LOGGER GALL/KREKOS

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
φ						4-INCH STICKUP RUBBER CAP
						SCH. 80 PVC 3/4" O.D.
5			1.2		SAND (SW), DK. YELL. BRN (10YR 4/2), DAMP, LOOSE, FINE GRAINED, 5-10% SILT, ORANGE MOTTLING	BENTONITE GRANULES
10			1.8		SILT (ML), DARK GRAY (N3), WET, MED. STIFF, SLIGHTLY PLASTIC, ORANGE MOTTLING, 5% FINE SAND	
15			1.5		SAND (SW), MED. DK. GRAY (N4), WET, LOOSE, V. FINE TO FINE-GRAINED, MICA, YELL. ORANGE MOTTLING, ≈5% SILT	10/20 SILICA SAND
20			1.8		SILT W/SAND (ML), MED. DK. GRAY (N4), WET, MED. STIFF, 15-20% V. FINE SAND	0.010" SCREEN

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493.B6.02	SDGP-04	1 OF 1

SOIL BORING LOG

GSE: 28.5'
MPE: 29.20'

PROJECT RMC - TROUTDALE LOCATION ~75' S. MW-25-024

ELEVATION DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD L0602 40

WATER LEVELS START 5-19-97 FINISH 5-19-97 LOGGER SMCREKOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP — 4 INCH STICKUP
						SCH 80 3/4" O.D.
5	4 6		1.3		SAND - (SW) - DRK. YELLOWISH BRWN 10YR 4/2, FINE GRAINED ORANGE MOTTLING, MOIST	
						BENTONITE GRANULAR
10	9 11		.8		SILT - (ML) - PALE BRWN 5YR 5/2, TRACE OF ORGANIC MATERIAL, NP, 10-15% SAND, MOIST	
						10/20 SILICA SAND
15	14 16		2.0		SILT - (ML) - OLIVE GRAY 5Y 4/1 MOIST, LOW PLASTIC, 5-10% FINE SAND, TRACE OF MICA.	0.010 SCREEN
20	18 20		1.8		SAME AS ABOVE.	

REV 11/89 FORM D158

(8.30)

CH2M HILL

PROJECT NUMBER 107493.D6.02 | BORING NUMBER SD6P-05 | SHEET 1 OF 1

SOIL BORING LOG

GSE = 28.0'
MPE = 28.80'

PROJECT RMC - TROUTDALE LOCATION ~100' So. MW-25-024

ELEVATION ______ DRILLING CONTRACTOR GEOTECH EXPLOR

DRILLING METHOD AND EQUIPMENT GH. 40 GEOPROBE START CARD #L06041

WATER LEVELS ______ START 5-19-97 FINISH 5-19-97 LOGGER SMCBE/CDS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP — 4 INCH STICKUP
						SCH 80 PVC 3/4" O.D.
5	4–6		1.2		SAND - (SW) - DRK. YELLOWISH BRWN. 10YR 4/2, FINE SAND MOIST, ORANGE MOTTLING	
						BENTONITE GRAN
10	9–11		1.4		SAND (SW) - PALE BRWN, 5YR 5/2, MED. TO FINE ORANGE MOTTLING.	
						10/20 SILICA SAND
15	14–16		.3		SILT - (ML) OLIVE GRAY 5Y 4/1 WET, LOW PLASTIC, 10-15% SAND FINE.	
						0.010 SCREEN
20	18–20		.1		SAME AS ABOVE	

REV 11/89 FORM D158

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493.D6.02	>DGP-06	1 OF 1

SOIL BORING LOG

GSE = 27.9
MPE = 28.6

PROJECT RMC - TROUTDALE LOCATION ~100' N. of MW-16-01?
ELEVATION ______ DRILLING CONTRACTOR GEOTECH
DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD # L060 42
WATER LEVELS ______ START 5-19-97 1410 FINISH 5-19/1500 LOGGER SMK

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP — 4" STICK UP
						SCH 80 PV 3/4" O.D
5	4 - 6		2.0		SILT - (ML) - DRK. YELLOWISH BRWN. 10 YR 4/2, MOIST, ORANGE MOTTLING, TRACE OF DRK. ORGANICS, 10-15% FINE SAND	
						BENTONITE GRAN.
10	9 - 11		1.1		SAND (SW) - BROWNISH GRAY 5YR 4/1, WET, MED. TO FINE SAND, SOME MOTTLING.	
						10/20 SILCA SAND
15	14 - 16		.4		SILT - (ML) WET, BROWNISH GRAY, 5 YR 4/1, NP, <5% SAND	
						0.010 SCREEN
20	18 - 20		1.6		SILT - (ML) MOIST, OLIVE GRAY 5Y 4/1, LOW PLASTIC,	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
1Ø7493 DL.Ø2	SDGP-Ø7	1 OF 1

SOIL BORING LOG

GSE = 27.8
MPE - 28.49

PROJECT RMC - TROUTDALE LOCATION ~130' N. of MW-16-Ø24

ELEVATION DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-4Ø GEOPROBE START CARD # LØ6Ø43

WATER LEVELS START 5-19-97 15Ø5 FINISH 5-19-97 LOGGER SMcRE/COS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP 4" STICKUP
						SCH. 8Ø PVC 3/4" O.D.
5	4 – 6		1.2		SAND-(SW)-MODERATE BROWN 5YR 4/4, MOIST, MED-FINE SAND, ORANGE MOTTLING.	GRANULAR BENTONITE
10	9 – 11		1.0		SAND (SW) BROWNISH GRAY 5YR 4/1 MED TO FINE SAND, WET, TRACE MICA	10/20 SILICA SAND
15	14 – 16		.8		SILT-(ML) MOIST, OLIVE GRAY 5Y 4/1, LOW PLASTIC,	0.010 SCREEN
20	18 – 2Ø		2.0		SILT (ML) SAME AS ABOVE.	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER 107493.D6.02

BORING NUMBER SDGP-08

SHEET 1 OF 1

SOIL BORING LOG

GSE = 28.3
MPE - 28.83

PROJECT RMC - TROUTDALE

LOCATION ~150' N. of MW-16-02

ELEVATION

DRILLING CONTRACTOR GEOTECH

START CARD # L00052

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE

WATER LEVELS

START 5-20-97 0915

FINISH 5-20 0945

LOGGER SMK

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP 4" STICK UP
						SCH 80 PVC 3/4" O.D.
5	4 6		1.2		SAND (SW) - MODERATE BROWN 5 YR 4/4, WET, MED-FINE SAND, ORANGE MOTTLING.	GRANULAR BENTONITE.
10	9 11		1.2		SAND (SW) - BROWNISH GRAY 5YR 4/1, MED-FINE SAND, WET, TRACE MICA	
						10/20 SILCA SAND
15	14 16		1.4		SILT - (ML) MOIST, OLIVE GRAY, 5 Y 4/1, LOW PLASTIC	0.010 SCREEN
20	18 20		1.6		SILT - (ML) - WET, OLIVE GRAY, 5Y 4/1, LOW PLASTIC.	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493.D6.02	3DGP-09	1 OF 1

SOIL BORING LOG

GSE = 20.9
MPE = 21.51

PROJECT RMC - TROUTDALE LOCATION ~250 FT S-SW of DECON PAD

ELEVATION ______ DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD L06244

WATER LEVELS ______ START 5-19-97 1340 FINISH 5-19 1600 LOGGER SAKREKOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP - 4" STICKUP
						SCH 80 PVC 3/4" O.D.
5	4–6		1.2		SILT-(ML) DUSKY YELLOWISH BROWN 10YR 2/2, MOIST, ROOTS IN SAMPLE SAND 10-15%	
10	9–11		.7		SILT-(ML) PALE BRWN. 5YR 5/2 WET, SOFT, LOW PLASTIC,	BENTONITE GRANULAR
15	14–16		-		NO RECOVERY	10/20 SILCA SAND
						0.010 SCREEN
20	18–20		1.0		SILT-(ML) OLIVE GRAY 5Y 4/1 MOIST, LOW PLASTIC, SOFT.	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
1Q7493.D6.Q2	SOGP-1Q	1 OF 1

SOIL BORING LOG

GSE = 21.5
MPE = 21.84

PROJECT RMC - TROUTDALE
LOCATION ~270 S-SW OF DECON PAD
ELEVATION
DRILLING CONTRACTOR GEOTECH
DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE
START CARD LQ6QSQ
WATER LEVELS
START 5-19-97 1605
FINISH 5-19-97
LOGGER TONKREIGOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP 4" STICK UP
						SCH 80 PVC 3/4" O.D.
5	4–6		1.2		SILT-(ML) DUSKY YELLOWISH BRWN, 10 YR 2/2, MOIST, TRACE OF ROOTS, SOFT. 10-15% FINES	
10	9–11		.9		SILT-(ML) PALE BROWN 5YR 5/2, FIRM, MOIST NP.	BENTONITE GRANULAR
15	14–16		NR		NO RECOVERY	10/20 SILCA SAND
	18–20		1.1		SILT-(ML) OLIVE GRAY 5Y 4/1 WET, LOW PLASTIC, FIRM	0.010 SCREEN
20						

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493.D6.02	SDGP-11	1 OF 1

SOIL BORING LOG

GSE = 22.3
MPE = 22.65

PROJECT RMC - TROUTDALE
LOCATION ~220 S.-SW OF DECON PA
ELEVATION
DRILLING CONTRACTOR GEOTECH
DRILLING METHOD AND EQUIPMENT GH · 4D GEOPROBE
START CARD # L06051
WATER LEVELS
START 5-20-97 0840
FINISH 5-20 905
LOGGER SMK

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP - 4" STICK UP
						SCH 80 PVC 3/4" O.D.
5	4 6		1.7		SILT - (ML) DUSKY YELLOWISH BRWN 10YR 2/2, MOIST FIRM, TRACE of ROOTS 10-15% SAND	
						GRANULAR BENTONITE
10	9 11		1.2		SILT (ML) PALE BRWN. 5YR 5/2 FIRM, MOIST, NP.	
						10/20 SILICA SAND
15	14 16		—		NO RECOVERY	
						0.010 SCREEN
20	18 20		1.8		SILT-(ML) OLIVE GRAY 5Y 4/1, WET, LOW PLASTIC FIRM	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493 D6.02	SDGP-12	1 OF 1

SOIL BORING LOG

GSE: 23.5
MPE - 24.07

PROJECT RMC - TROUTDALE LOCATION ~ 200 S-SW OF DECON PAD

ELEVATION DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH - 40 GEOPROBE START CARD # L06053

WATER LEVELS START 5.20.97 0950 FINISH 5.20 LOGGER SMK

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP - 3" STICKUP. SCH 80 PVC 3/4" O.D.
5	4 - 6		1.8		SILT-(ML) DUSKY YELLOWISH BRWN, 10YR 2/2, MOIST, FIRM, TRACE OF ROOTS, 10-15% SAND	BENTONITE GRANULAR
10	9 - 11		1.3		SILT(ML) PALE BRWN, 5 YR 5/2, MOIST, FIRM NR TRACE OF FINE SAND	
15	14 - 16		—		NO RECOVERY	10/20 SILCA SAND 0.010 SCREEN
20	18 - 20		1.4		SILT(ML) OLIVE GRAY, SOFT, WET, LOW PLASTIC 5-10% SAND	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493. D6.02	SDGP-13	1 OF 1

SOIL BORING LOG

GSE = 22.0
MPE = 22.49

PROJECT RMC - TROUTDALE LOCATION ~140' E of MW-4

ELEVATION ______ DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD # L06056

WATER LEVELS ______ START 5-20-97 1110 FINISH 5-20 LOGGER RMC

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP - 4" STICKUP
						SCH 80 PVC 3/4" O.D
5	4 – 6		1.7		SILT - DRK. YELLOWISH BRWN 10YR 4/2, SOFT, MOIST, ROOTS + ORGANIC MATERIAL PRESENT, ORANGE MOTTLING LOW PLASTIC (ML) 5-10% SAND	GRANULAR BENTONITE
10	9 – 11		.8		SILT - PALE YELLOWISH BRWN 10YR 6/2, WET, V.SOFT, ROOTS PRESENT, ORANGE MOTTLING, LOW PLASTIC (ML)	10/20 SILICA SAND
15	14 – 16		NR		No RECO	0.010 SCREEN
20	18 – 20		1.8		SILT w/SAND - DRK. GREENISH GRAY 5GY 4/1, WET SOFT, 15-20% FINE SAND	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
107493.D6.QZ	SDGP-14	1	1

SOIL BORING LOG

GSE = 21.8
MPE = 22.27

PROJECT RMC - TROUTDALE LOCATION ~145' E of MW-4

ELEVATION ______ DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD# L060257

WATER LEVELS ______ START 5-20-97 1130 FINISH 5-20 LOGGER SMKRPKOS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						CAP. 4" STICKUP
						SCH 80 PVC 3/4" O.D.
5	4–6		1.7		SILT - DRK. Yellowish BRWN. 10YR 4/2, SOFT, MOIST, ROOTS + ORGANIC MATERIAL PRESENT, ORANGE MOTTLING LOW PLASTIC, 5-10% SAND (ML)	
						GRANULAR BENTONITE
10	9–11		1.3		SILT - PALE Yellowish BRWN 10YR 6/2, WET, V. SOFT ROOTS PRESENT, ORANGE MOTTLING, LOW PLASTIC TRACE FINE SAND (ML)	
						10/20 SILICA SAND
15	14–16		NR		No RECOVERY	
						0.010 SCREEN
20	18–20		0.9		SILT W/ SAND - DRK GREENISH GRAY, 5GY 4/1, WET V. SOFT, 15-20% FINE SAND (ML)	

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493 D6Q2	SDGP-15	1 OF 1

SOIL BORING LOG

GSE = 22.6
MPE = 23.21

PROJECT RMC - TROUTDALE
LOCATION ~100 SO. OF ABSORB. STORE
ELEVATION
DRILLING CONTRACTOR GEOTECH
DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE
START 5-20-97 1045
START 5-20 CARD # LQ6055
WATER LEVELS
FINISH 1105
LOGGER SML

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						4" STICKUP
						SCH 80 PVC 3/4" O.D.
5	4 - 6		1.0		SILTY SAND - MODERATE YELLOWISH BROWN 10YR 5/4 SOFT, ORANGE MOTTLING 15-25% FINE SAND (SM)	
10	9 - 11		.3		SILT - DRK. YELLOWISH BRN. 10YR 4/2, SOFT, WET, NP, TRACE OF FINE SAND. (ML)	GRANULAR BENTONITE
						10/20 SILCA SAND
15	14 - 16		1.3		SILTY SAND - WET, OLIVE GRAY 5Y 4/1, V. SOFT, 15-25% FINE SAND (SM)	0.010 SCREEN
20	18 - 20		1.7		SILTY SAND - SIMILAR TO ABOVE (SM)	

REV 11/89 FORM D158

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
107493 D6 Q2	SDGP- 16	1 OF 1

SOIL BORING LOG

GSE = 23.7
MPE = 24.3

PROJECT RMC - TROUTDALE LOCATION ~80 So. of OIL ABSORB STORA

ELEVATION DRILLING CONTRACTOR GEOTECH

DRILLING METHOD AND EQUIPMENT GH-40 GEOPROBE START CARD # LQ6Q54

WATER LEVELS START 5-20-97 1020 FINISH 5-20 1040 LOGGER SMK

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						3" STICKUP
						SCH 80 PVC 3/4" O.D.
5	4 6				SILTY SAND - MODERATE YELLOWISH BROWN, 10YR 5/4 SOFT, ORANGE MOTTLING, 15-20% FINE SAND (SM)	
10			NR	1	No RECOVERY	
						GRANULAR BENTONITE
15	14 16		NR		SILTY SAND - WET, OLIVE GRAY 5Y 4/1, V. SOFT, 15-25% FINE SAND	SILCA SAND 10/20
20	18 20		.1		SILTY SAND - SIMILAR TO ABOVE	0.010 SCREEN

(8.30)

REV 11/89 FORM D1586

Week of: 5-19-97

Project: TROUT DALE

Client: CH2M HILL

Driller: THOMAS C WILSON

GEO-TECH EXPLORATIONS, inc.

GEOPROBE UNIT

Tualatin Office 692-6400
Seattle Office 242-7441
Toll Free 1-800-275-3885

CODE	DESCRIPTION	M	T	W	TH	F	TOTAL	CODE	DESCRIPTION	M	T	W	TH	F	TOTAL
0001	MOBILIZATION							6010	TYVEKS						
0500	OR START CARDS							6015	GLOVES						
0510	WA START CARDS							6020	RES. CARTIDGES						
1730	GEOPROBE 1 MAN CREW							9005	AT-14 DRIVE POINT						
1735	GEOPROBE 2 MAN CREW							9006	AT-665K LB CLEAR LINER						
1820	LEVEL C PROTECT 2 MAN							9007	AT-666 LB BRASS LINER						
1821	LEVEL C PROTECT 1 MAN							9008	AT-667 LB SS LINER						
								9009	AT-668 LB TEFLON LINER						
4040	BENTONITE							9010	AT-641K LB END CAP						
4045	ENVIROGROAT							9011	AT-725K MC CLEAR LINER						
4060	PORTLAND CEMENT							9012	AT-726K MC END CAPS						
4070	READY MIX														
4075	COLD PATCH							9013	GW-445 GW DRIVE POINT						
4095	QUICKSET							9014	GW-42 CHECK VALVE						
								9015	3/8 X 1/4 ID POLY TUBE						
5015	DRUM							9016	1/4 X .17 ID POLY TUBE						
5020	SUBSISTENCE TWO MAN							9017	3/8X5/16 TEFLON TUBE						
5021	SUBSISTENCE ONE MAN							9018	AT-86-17S GW 3/1X6 IMP.						
5030	STEAM CLEANER							9019	AT-87-25S 21" SCRN IMP.						
5040	GENERATOR							9020	PR-14 IMPLANT ANCHOR						
5045	DECON TRAILER							9021	AT-84 GLASS BEADS						
									EXPENDABLE PTS.	1					1
									TOTAL HRS	6.5 HR					6.5 HR

MISC. COMPLETED 9 BORINGS COLLECTING SOIL SAMPLES EVERY 5' TO 20'
INSTALL PIEZO' 5' SCREEN 15' BLANK

JOB No. 107493.D6.04

Week of: 5-20-97
Project: TROUTDALE
Client: CH2M HILL
Driller: THOMAS C. WILSON

GEO-TECH EXPLORATIONS, inc.

GEOPROBE UNIT

Tualatin Office 692-6400
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CODE	DESCRIPTION	M	T	W	TH	F	TOTAL
0001	MOBILIZATION						
0500	OR START CARDS						
0510	WA START CARDS						
1730	GEOPROBE 1 MAN CREW						
1735	GEOPROBE 2 MAN CREW						
1820	LEVEL C PROTECT 2 MAN						
1821	LEVEL C PROTECT 1 MAN						
4040	BENTONITE						
4045	ENVIROGROAT						
4060	PORTLAND CEMENT						
4070	READY MIX						
4075	COLD PATCH						
4095	QUICKSET						
5015	DRUM						
5020	SUBSISTENCE TWO MAN						
5021	SUBSISTENCE ONE MAN						
5030	STEAM CLEANER						
5040	GENERATOR						
5045	DECON TRAILER						

CODE	DESCRIPTION	M	T	W	TH	F	TOTAL
6010	TYVEKS						
6015	GLOVES						
6020	RES. CARTIDGES						
9005	AT-14 DRIVE POINT						
9006	AT-665K LB CLEAR LINER						
9007	AT-666 LB BRASS LINER						
9008	AT-667 LB SS LINER						
9009	AT-668 LB TEFLON LINER						
9010	AT-641K LB END CAP						
9011	AT-725K MC CLEAR LINER						
9012	AT-726K MC END CAPS						
9013	GW-445 GW DRIVE POINT						
9014	GW-42 CHECK VALVE						
9015	3/8 X 1/4 ID POLY TUBE						
9016	1/4 X .17 ID POLY TUBE						
9017	3/8X5/16 TEFLON TUBE						
9018	AT-86-17S GW 3/1X6 IMP.						
9019	AT-87-25S 21" SCRN IMP.						
9020	PR-14 IMPLANT ANCHOR						
9021	AT-84 GLASS BEADS						
	TOTAL HRS		4.0				4.0

MISC. COMPLETED 7 BORINGS FOR SOIL SAMPLES EVERY 5' TO 20' AND [illegible]

JOB NO. 107493-D6-04

4/15-94

ATTACHMENT B

Company Lake Water Balance – Influent and Effluent Flow Metering System Description

Company Lake Water Balance - Influent and Effluent Flowmetering System Descriptions

Following is a description of the flowmetering systems that were installed at the Company Lake inlet and outlet for the water balance performed in September and October 1997.

Inlet Flowmetering System

CH2M HILL installed an ultrasonic flowmetering system on the 16-inch-diameter carbon steel pipe discharging to the southwest corner of Company Lake. The influent pipe wrapping material was found to contain 18 percent non-friable[1] chrysotile asbestos fibers; a section of the pipe was cleaned by a certified asbestos abatement contractor in preparation for installing the flowmetering system. The system was located along the southern slope of the U.S. Army Corps of Engineers dike. The system and housing consisted of the following:

Ultrasonic Flowmeter - The Polysonics flowmeter Model DCT 1088 is noninvasive (that is, it measures flow from outside the pipe). The flowmeter has the ability to differentiate velocity in both the positive and negative directions; hence, totalized flow reflects net inflow to Company Lake. The flowmeter was programmed in the field using a portable computer and TimeGate software, a Windows 95-based configuration and graphical signal analysis utility provided by the manufacturer. The configuration program specified the transducer spacing on the pipe.

The configuration settings are stored in the flowmeter's nonvolatile memory to protect them in the event of power failure. Input configuration parameters include:

- Pipe outside diameter, wall thickness, material, sound speed, and inside roughness
- Liner thickness, material, sound speed, and inside roughness
- Fluid type, sound speed, and viscosity
- Transducer type and mounting style
- Zero set calibration and scale factor calibration
- Flow units, minimum and maximum flow range values, and damping cutoffs
- Enable totalizers, totalizer units and multiplier
- Flowmeter and display options

Signal Transducers - The ultrasonic signal transducers (one transmitter and one receiver) were mounted on the cleaned section of the pipe and the transducer cables are routed to the ultrasonic flowmeter located inside the portable building.

Digital Readout - The flowmeter's 8-digit backlit liquid crystal display screen displays the instantaneous flow rate and totalized net flow in units of hundred of gallons.

[1] Per PAS Consultants, friable material is defined as that which is able to be "hand crushed or pulverized."

Power Supply - The metering station is powered by four 50-watt Siemans M55 Solar Panels mounted on top of the portable building. Power to six deep cycle 12-volt DC batteries is regulated using a 12-volt DC photovoltaic charge controller. The batteries are housed in a polypropylene molded battery enclosure.

Calibration - The flowmeter was calibrated in the field using the zero-set method. To perform the zero set, the Company Lake influent pumps were manually powered down such that there was no flow in the pipe. The meter was then set to zero flow.

Security - The flowmeter is contained in a portable building and the solar panels, power controller and batteries are located atop the building; the perimeter of the building roof is fenced with barbed wire. The area around the building and transducer assemblies is fenced to discourage vandalism.

Manual Data Logging - A data logging sheet is located inside the building to allow field staff to record date, time, and totalized flow at various times during the water balance data collection period.

Outfall Flowmetering System

CH2M HILL designed and constructed an effluent flowmetering system downstream of the Parshall flume at the north end of Company Lake. The system was sized to improve flow measurement accuracy for the low flow rates common during the summer months. The system was designed to provide redundant data to the existing Parshall flume at effluent flow rates less than approximately 1.3 mgd. The system consisted of the following:

Collection Sump - This drop inlet consists of a concrete box immediately downstream of the existing Parshall flume. An aluminum baffle wall is installed atop the drop inlet to direct the flow through a submerged 8-inch discharge pipe to the existing holding pond. The baffle also will force high water downstream of the flume through the ultrasonic flowmetering structure in the case of flow reversal.

Signal Transducers - An ultrasonic signal transmitter and a receiver are affixed adjacent to one another on the 8-inch PVC discharge pipe in the V-configuration. This section of the pipe is submerged.

Ultrasonic Flowmeter - A Polysonics Model DCT6088, Dedicated Digital Correlation Transit Time Ultrasonic Flowmeter was installed to quantify net flow out of the Lake.

Instantaneous Flow Datalogging - The datalogger is programmed to record the instantaneous flow in units of gallons per day, and the date and time at 1-minute intervals. The datalogger is capable of storing 10,000 data points (equivalent to 6.9 days of data.)

Digital Readout - The flowmeter screen displays the instantaneous flow rate and totalized net flow in units of hundred of gallons.

Calibration - The installed ultrasonic flowmeter was empirically calibrated on a flow loop in the factory before it was shipped. In addition, the flowmeter was configured in the field using a portable PC and TimeGate software. The flowmeter was calibrated in the field using the zero-set method. To perform the zero set, the pipe was submerged and end caps were placed on each end. The meter was then set to zero flow.

ATTACHMENT C

Groundwater Quality Near Company Lake

Groundwater Quality Near Company Lake

Geoprobe Station ID	GP20-042	GP21-034	GP21-082	GP37-022	GP38-022	GP39-022	GP40-012	GP41-032	GP42-032	GP43-032	GP44-012	GP45-032
Date Sampled	9/19/97	9/24/97	9/25/97	9/29/97	9/29/97	9/30/97	9/30/97	10/2/97	10/6/97	9/26/97	9/26/97	10/9/97
Analyte												
Conventional (mg/L)												
Alkalinity, Carbonate as CaCO3	6 U	6 U		6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Bicarbonate (as CaCO3)	68	142		140	137	110	39	163	268	161	146	127
Chloride	58.3	9.26		40.8	21.6	19.8	1.05 U	2.92	3.45	6.86	3.65	2.18
Cyanide, Total	0.02 U	0.02 U		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Fluoride By 300.0	4.45	0.61	10.3	17.1	2.9	11.4	2.85	0.25 U	0.25 U	0.27	4.45	0.29
Nitrate-N	0.1	3		1 U	1 U	1 U	1.3	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Sulfate	14	38.4		10.3	7.7	6.02	2.58	4.51	18.1	9.29	4.54	1.24
Metals-Total (mg/L)												
Aluminum	60.5	57.1		5.44	0.112	5.54	2.48	10.1	85.5	288	11.6	102
Beryllium	0.0014	0.0012		0.00036	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0023	0.0093	0.00054	0.0026
Cadmium	0.0029	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0029	0.0074	0.002 U	0.0036
Calcium	55.8	44.6		45.2	22.4	24.9	7.13	24.5	66.9	115	17.4	50
Iron	103	94		7.25	0.1 U	2.51	5.03	12.9	128	440	9.88	162
Magnesium	22.9	23.5		5.65	3.56	4.22	2.94	14.3	35.9	102	9.17	27.9
Manganese	0.715	0.66		1.08	0.0768	0.153	0.135	0.345	7.25	4.55	0.169	2.82
Potassium	5.12	4.58		3.72	4.16	3.71	3.01	1.81	7.3	20.3	1.96	7.21
Sodium	26.8	19.2		37.1	23.5	28.2	6.09	9.8	21.7	25.3	27.7	19.8
Metals-Dissolved (mg/L)												
Aluminum	0.323	0.15		1.13	0.112	0.519	0.595	0.0844	0.0569	0.268	0.363	0.221
Beryllium	0.0003 U	0.0003 U		0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Cadmium	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Iron	7.05	2.02		5.7	0.102	0.488	1.68	0.924	14.3	2.1	0.17	2.99
Manganese	0.152	0.0997		1.04	0.0777	0.1	0.0803	0.234	5.65	0.663	0.0278	1.05
PAHs (mg/L)												
Acenaphthene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Acenaphthylene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Anthracene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(a)anthracene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(a)pyrene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(b)fluoranthene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(g,h,i)perylene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Benzo(k)fluoranthene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Chrysene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Dibenzo(a,h)anthracene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluoranthene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluorene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Indeno(1,2,3-cd)pyrene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Naphthalene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Phenanthrene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Pyrene	0.0001 U	0.0001 U		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
VOC (mg/L)[a]												
1,1,1-Trichloroethane							0.001 U	0.014	0.001 U			0.001 U
Benzene							0.001 U	0.014	0.001 U			0.001 U
1,1-Dichloroethane							0.001 U	0.016	0.001 U			0.001 U
1,1-Dichloroethene							0.001 U	0.003	0.001 U			0.001 U

[a]VOCs analyzed at 4 geoprobe locations (GP40, GP41, GP42, and GP45). Only those VOC species that were detected are shown.

U = Not Detected

ATTACHMENT D

1994-1997 Groundwater Levels for Upper Gray Sand and Intermediate-Depth Wells in Company Lake Area

1994 - 1997 Groundwater Levels for Upper Gray Sand and Intermediate-Depth Wells in Company Lake Area

Reynolds Metals Company - Troutdale, Oregon

CL Staff Gauge

Date	Time	WLE (feet)
04/04/97	8:25	16.18
05/01/97	11:00	
06/04/97	10:50	
09/02/97	10:40	15.50
10/03/97	9:00	15.98
11/07/97	11:45	16.00
12/03/97	9:10	15.37
01/06/98	9:40	15.60
02/05/98	8:48	15.80

MW06-024 (UGS)

Date	Time	WLE (feet)
07/20/94	0:00	10.04
08/08/94	0:00	8.36
09/08/94	0:00	7.53
10/07/94	0:00	6.61
10/28/94	0:00	8.89
12/13/94	0:00	10.91
01/04/95	0:00	10.98
02/02/95	0:00	15.65
03/01/95	0:00	13.88
04/04/95	0:00	11.32
05/03/95	0:00	13.48
06/06/95	0:00	13.89
06/28/95	0:00	13.85
08/01/95	0:00	10.30
09/07/95	0:00	8.07
10/05/95	0:00	8.37
11/03/95	0:00	9.01
12/01/95	0:00	19.61
01/04/96	0:00	15.06
02/02/96	0:00	15.61
03/01/96	0:00	20.32
04/01/96	0:00	15.05
05/06/96	0:00	17.62
06/07/96	0:00	19.46
07/01/96	0:00	15.91
08/01/96	0:00	11.98
09/04/96	0:00	9.45
10/02/96	0:00	8.69
11/04/96	0:00	8.61
12/02/96	0:00	13.94
01/06/97	0:00	22.48
02/05/97	9:20	19.45
02/28/97	8:35	16.78
03/11/97	8:30	17.40
04/04/97	8:05	17.76
05/01/97	9:30	21.70
06/04/97	11:50	23.06
07/01/97	9:40	18.86
08/06/97	10:10	13.63
09/02/97	10:45	12.03
10/03/97	9:45	11.12
11/07/97	10:05	11.49
12/03/97	10:05	11.62
01/06/98	10:10	12.61
02/05/98	9:30	13.54

MW07-024 (UGS)

Date	Time	WLE (feet)
07/20/94	0:00	14.88
08/08/94	0:00	13.94
09/08/94	0:00	12.25
10/07/94	0:00	9.02
10/28/94	0:00	8.70
12/13/94	0:00	19.82
01/04/95	0:00	21.48
02/02/95	0:00	24.08
02/17/95	0:00	23.81
03/01/95	0:00	23.93
04/04/95	0:00	21.93
05/03/95	0:00	21.92
06/06/95	0:00	20.80
06/28/95	0:00	20.36
08/01/95	0:00	18.58
09/07/95	0:00	15.99
10/05/95	0:00	14.15
11/03/95	0:00	14.26
12/01/95	0:00	23.26
01/04/96	0:00	23.80
02/02/96	0:00	24.51
03/01/96	0:00	25.45
04/01/96	0:00	23.23
05/06/96	0:00	23.44
06/07/96	0:00	23.15
07/01/96	0:00	21.79
08/01/96	0:00	20.15
09/04/96	0:00	18.24
10/02/96	0:00	16.72
11/04/96	0:00	17.88
12/02/96	0:00	24.00
01/06/97	0:00	26.40
02/05/97	10:00	25.58
02/28/97	9:07	23.27
03/11/97	8:20	24.88
04/04/97	8:55	23.70
05/01/97	8:35	24.13
06/04/97	10:50	24.19
07/01/97	10:00	23.26
08/06/97	11:00	20.80
09/02/97	12:00	19.70
10/03/97	9:15	17.96
11/07/97	10:55	12.68
12/03/97	10:12	19.16
01/06/98	9:25	21.31
02/05/98	10:15	23.10

MW20-026 (UGS)

Date	Time	WLE (feet)
09/07/95	0:00	8.09
10/05/95	0:00	7.66
11/03/95	0:00	8.39
12/01/95	0:00	16.68
01/04/96	0:00	14.39
02/02/96	0:00	15.83
03/01/96	0:00	19.82
04/01/96	0:00	15.01
05/06/96	0:00	17.35
06/07/96	0:00	19.38
07/01/96	0:00	15.83
08/01/96	0:00	12.16
09/04/96	0:00	9.97
10/02/96	0:00	8.56
11/04/96	0:00	8.85
12/02/96	0:00	12.15
01/06/97	0:00	22.55
02/05/97	9:50	18.59
02/28/97	9:01	15.43
03/11/97	8:06	15.40
04/04/97	8:05	17.33
05/01/97	9:05	22.01
06/04/97	10:35	24.89
07/01/97	9:10	17.73
08/06/97	10:00	12.52
09/02/97	10:35	11.00
10/03/97	9:15	10.15
11/07/97	9:35	10.12
12/03/97	11:00	10.31
01/06/98	8:50	10.59
02/05/98	8:50	12.91

MW22-027 (UGS)

Date	Time	WLE (feet)
09/07/95	0:00	7.72
10/05/95	0:00	7.27
11/03/95	0:00	8.08
12/01/95	0:00	16.31
01/04/96	0:00	14.00
02/02/96	0:00	15.58
03/01/96	0:00	19.87
04/01/96	0:00	14.66
05/06/96	0:00	17.41
06/07/96	0:00	19.32
07/01/96	0:00	15.68
08/01/96	0:00	11.68
09/04/96	0:00	9.47
10/02/96	0:00	8.07
11/04/96	0:00	8.40
12/02/96	0:00	11.85
01/06/97	0:00	22.12
02/05/97	9:45	18.65
02/28/97	8:59	15.20
03/11/97	7:54	15.19
04/04/97	8:45	17.36
05/01/97	8:55	21.99
06/04/97	10:10	24.93
07/01/97	9:00	17.78
08/06/97	9:45	11.97
09/02/97	10:30	10.57
10/03/97	9:00	9.64
11/07/97	9:25	9.74
12/03/97	10:55	10.00
01/06/98	9:05	10.27
02/05/98	9:00	12.56

MW27-045 (UGS)

Date	Time	WLE (feet)
11/04/96	0:00	7.59
12/02/96	0:00	12.01
01/06/97	0:00	22.08
02/05/97	9:30	18.36
02/28/97	8:50	15.09
03/11/97	7:46	15.05
04/04/97	11:15	16.87
05/01/97	8:45	21.97
06/04/97	10:00	24.63
07/01/97	8:55	16.97
08/06/97	9:30	11.13
09/02/97	9:50	9.89
10/03/97	9:25	9.56
11/07/97	9:15	9.61
12/03/97	10:40	9.75
01/06/98	9:10	10.17
02/05/98	9:10	12.11

MW29-033 (UGS)

Date	Time	WLE (feet)
11/04/96	0:00	10.27
12/02/96	0:00	13.80
01/06/97	0:00	22.08
02/05/97	9:25	18.90
02/28/97	8:38	15.89
03/11/97	8:27	16.52
04/04/97	8:20	17.37
05/01/97	9:10	21.55
06/04/97	9:35	23.55
07/01/97	9:55	17.40
08/06/97	10:05	12.28
09/02/97	10:40	10.91
10/03/97	9:40	10.53
11/07/97	10:50	11.01
12/03/97	10:10	11.12
01/06/98	10:15	11.82
02/05/98	9:30	13.20

MW30-030 (UGS)

Date	Time	WLE (feet)
01/06/97	0:00	22.17
02/05/97	9:05	18.44
02/28/97	8:21	15.25
03/11/97	8:37	15.44
04/04/97	7:50	16.74
05/01/97	9:15	21.72
06/04/97	12:00	24.16
07/01/97	9:25	16.67
08/06/97	10:20	11.38
09/02/97	10:55	9.38
10/03/97	9:55	9.25
11/07/97	10:20	9.47
12/03/97	9:45	9.45
01/06/98	9:40	10.33
02/05/98	9:45	11.91

1994 - 1997 Groundwater Levels for Upper Gray Sand and Intermediate-Depth Wells in Company Lake Area
Reynolds Metals Company - Troutdale, Oregon

Date	Time	WLE	Date	Time	WLE	Date	Time	WLE	Date	Time	WLE	Date	Time	WLE
		(feet)			(feet)			(feet)			(feet)			(feet)
MW06-094 (I)			MW27-081 (I)			MW29-090 (I)			MW30-100 (I)			Columbia River		
10/02/96	0:00	8.15	09/04/96	0:00	8.29	10/02/96	0:00	8.49	01/06/97	0:00	21.56	07/20/94		8.18
11/04/96	0:00	7.87	10/02/96	0:00	7.82	11/04/96	0:00	8.52	02/05/97	9:05	18.23	08/08/94		6.80
12/02/96	0:00	12.63	11/04/96	0:00	7.32	12/02/96	0:00	12.78	02/28/97	8:22	14.68	09/08/94		4.31
01/06/97	0:00	21.68	12/02/96	0:00	12.21	01/06/97	0:00	21.82	03/11/97	8:37	15.30	10/07/94		5.28
02/05/97	9:20	18.31	01/06/97	0:00	21.76	02/05/97	9:25	12.26	04/04/97	7:50	16.22	10/28/94		6.59
02/28/97	8:37	15.12	02/05/97	9:30	18.34	02/28/97	8:38	15.19	05/01/97	9:15	21.71	12/13/94		7.53
03/11/97	8:30	15.60	02/28/97	8:50	14.95	03/11/97	8:27	15.69	06/04/97	12:00	24.29	01/04/95		7.35
04/04/97	8:05	16.64	03/11/97	7:46	15.32	04/04/97	8:20	16.84	07/01/97	9:25	15.67	02/02/95		14.84
05/01/97	9:30	21.36	04/04/97	11:15	16.53	05/01/97	9:10	21.44	08/06/97	10:20	10.93	02/17/95		12.25
06/04/97	11:50	23.67	05/01/97	8:45	21.77	06/04/97	9:35	23.65	09/02/97	10:55	8.86	03/01/95		10.93
07/01/97	9:40	16.55	06/04/97	10:00	24.31	07/01/97	9:55	16.77	10/03/97	9:55	9.36	04/04/95		7.83
08/06/97	10:10	11.25	07/01/97	8:55	16.34	08/06/97	10:05	11.49	11/07/97	10:20	9.56	05/03/95		12.54
09/02/97	10:45	9.77	08/06/97	9:30	11.18	09/02/97	10:40	10.12	12/03/97	9:45	9.39	06/06/95		12.48
10/03/97	9:45	9.73	09/02/97	9:50	9.54	10/03/97	9:40	9.92	01/06/98	9:40	10.56	06/28/95		12.95
11/07/97	10:05	10.16	10/03/97	9:25	9.65	11/07/97	10:50	10.37	02/05/98	9:45	11.47	08/01/95		8.35
12/03/97	10:05	10.12	11/07/97	9:15	9.82	12/03/97	10:10	10.41				09/07/95		4.29
01/06/98	10:10	10.95	12/03/97	10:40	9.80	01/06/98	10:15	11.05				10/05/95		5.68
02/05/98	9:30	12.08	01/06/98	9:10	10.62	02/05/98	9:30	12.10				11/03/95		5.56
			02/05/98	9:10	11.90							12/01/95		21.67
												01/04/96		13.09
												02/02/96		13.63
												03/01/96		18.73
												04/01/96		10.71
												05/06/96		16.28
												06/07/96		19.19
												07/01/96		14.25
												08/01/96		10.40
												09/04/96		6.06
												10/02/96		6.48
												11/04/96	9:46	4.13
												12/02/96	7:50	11.43
												01/06/97	10:00	11.74
												02/05/97	9:00	18.28
												02/28/97	8:20	13.89
												03/11/97	8:34	15.03
												04/04/97	7:50	15.44
												05/01/97	10:15	22.00
												06/04/97	10:50	24.80
												07/01/97	9:30	13.98
												08/06/97	10:15	10.72
												09/02/97	10:55	7.42
												10/03/97	9:55	9.40
												11/07/97	10:15	10.00
												12/03/97	9:30	8.80
												01/06/98	9:35	10.52
												02/05/98	9:40	10.57